



FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges

Report AV2023036
June 21, 2023



FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges

Requested by the Ranking Members of the U.S. House Committee on Transportation and Infrastructure and its Subcommittee on Aviation

Federal Aviation Administration | AV2023036 | June 21, 2023

What We Looked At

The Federal Aviation Administration (FAA) is responsible for safely managing the National Airspace System (NAS). This requires coordinating commercial and military aviation with increasing numbers of commercial space transportation launches and reentries. Citing this increasing frequency and the need to integrate commercial space operations into the NAS, the Ranking Members of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation requested that we examine the FAA's Space Data Integrator (SDI) program and other actions taken by FAA and the aerospace industry related to commercial space integration. Our audit objectives were to assess (1) FAA's progress in implementing the SDI program and (2) actions taken and planned by FAA and the aerospace and aviation industries to integrate commercial space operations into the NAS.

What We Found

FAA deployed an SDI prototype in 2021, but its effectiveness in providing launch and reentry data to stakeholders is limited because it only receives data from one operator, only tracked one launch at a time until recently, and is only installed at the FAA Command Center. Additionally, FAA has not finalized plans and requirements for a successor program intended to leverage the SDI prototype. The Agency is not expected to make a Final Investment Decision regarding this new program until September 2027, with the intention of gradual implementation through fiscal year 2032. FAA has connected with stakeholders to provide input on commercial space integration issues and implemented some of their recommendations. However, FAA has postponed taking action on other identified shortfalls and recommendations pending final decisions on implementing a successor program for SDI, which is now delayed. Finally, while FAA has implemented procedures aimed at reducing the amount of time commercial space operations impact NAS airspace, the Agency faces operational and policy challenges to efficiently integrate these operations.

Our Recommendations

We made four recommendations to improve FAA's ability to provide and capture information regarding its efforts to integrate commercial space operations. FAA concurred with all four recommendations and provided appropriate planned actions and completion dates.

Contents

Memorandum	1
Background	3
Results in Brief	5
FAA Deployed an SDI Prototype, but Its Effectiveness Is Limited, and FAA Has Not Made Key Program Decisions	7
FAA Is Working With Commercial Space and Aviation Stakeholders but Faces Challenges To Successfully Integrate Commercial Space Operations	13
Conclusion	23
Recommendations	24
Agency Comments and OIG Response	24
Actions Required	25
Exhibit A. Scope and Methodology	26
Exhibit B. Organizations Visited or Contacted	28
Exhibit C. List of Acronyms	30
Exhibit D. Status of the 2019 Commercial Space ARC Recommendations	31
Exhibit E. Major Contributors to This Report	36
Appendix A. Agency Comments	37
Appendix B. Nongovernmental Organization Responses	39



Memorandum

Date: June 21, 2023

Subject: ACTION: FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges | Report No. AV2023036

From: Nelda Smith *Nelda Smith*
Assistant Inspector General for Aviation Audits

To: Federal Aviation Administrator

The Federal Aviation Administration (FAA) coordinates nearly 43,000 flights daily and manages approximately 5,000 aircraft in the National Airspace System (NAS) at any given time. In addition to commercial and military aviation, the commercial space industry uses the NAS to conduct launch and reentry operations for transporting astronauts and supplies; placing commercial, military, and scientific satellites into orbit; and transporting civilian passengers into space. These space operations are also growing. In June 2021, FAA reported that over the preceding 5-year period, the Agency went from licensing about one commercial space launch every month to licensing more than one launch every week.

Currently, FAA manages the NAS during commercial space activities through airspace segregation, which involves shutting down portions of the surrounding airspace to protect commercial carriers and other airspace users from potential hazards. However, this results in increased operational inefficiencies and costs to these users, who must delay or reroute their flights. To help reduce these impacts, FAA developed the Space Data Integrator (SDI), a software system that integrates vehicle launch and reentry data from commercial space operations directly into FAA's air traffic management tools. SDI, along with additional procedures, is expected to help FAA decrease the amount of time that restricted airspace is needed for commercial space operations, allowing for more efficient use of the NAS.

Citing the increasing frequency and complexity of commercial space transportation launches and the need to integrate these operations into the NAS,

the Ranking Members¹ of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation requested that we examine the SDI program, including the system's existing and future capabilities, timeline for full utilization, and relationship to other commercial space transportation integration programs. They also requested that we examine other actions by FAA and the aerospace industry related to commercial space integration, such as the Agency's changes to air traffic procedures and equipment modifications.

Accordingly, our audit objectives were to assess (1) FAA's progress in implementing the SDI program and (2) actions taken and planned by FAA and the aerospace and aviation industries to integrate commercial space operations into the NAS.

We conducted this audit in accordance with generally accepted Government auditing standards. Exhibit A details our scope and methodology. Exhibit B lists the organizations we visited or contacted, and exhibit C lists the acronyms used in this report.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please contact me or Robin Koch, Program Director.

cc: The Secretary
 DOT Audit Liaison, M-1
 FAA Audit Liaison, AAE-100

¹ On August 4, 2020, Ranking Member Sam Graves of the U.S. House Committee on Transportation and Infrastructure and Ranking Member Garret Graves of the Subcommittee on Aviation requested this audit.

Background

According to the U.S. Space Priorities Framework,² access to and use of space is a vital national interest that underpins our national security, delivers tangible economic opportunity and other benefits to the American people, and spurs innovation and inspiration. The United States has set fostering an environment that enables a competitive and burgeoning U.S. commercial space sector as a national space policy priority. The Administration has recognized the importance of the commercial space industry and committed the United States to maintaining U.S. space leadership.

Currently, the global space industry is approximately \$400 billion in size and is expected to generate \$1.1 trillion or more in revenue by 2040, most of which is generated commercially, with the United States comprising a little less than half of this activity. Commercial space launches from the United States include payloads ranging from satellites that support internet and other information technology to those critical to national defense, emergency response, and other vital Government functions, as well as, to date, a limited number of human space missions.

To oversee and regulate the U.S. commercial space transportation industry, Congress established the Office of Commercial Space Transportation in 1984. Originally part of the Office of the Secretary of Transportation within the Department of Transportation (DOT), the Office was transferred to FAA in 1995, giving the Agency the authority to license all commercial launches that take place within U.S. borders or are conducted abroad by U.S. entities, promote the commercial space industry, and facilitate the strengthening and expansion of space transportation infrastructure.

FAA's Air Traffic Organization is also responsible for ensuring that commercial launch and reentry operations are safely separated from other flights. To do this, prior to a commercial space launch, a pre-mission planning and review process takes place between various FAA organizations, the space launch or reentry operator, and other affected parties such as Federal ranges.³ See figure 1 for a detailed illustration of this process. This includes:

- Establishing a letter of agreement between FAA and the space launch or reentry operator on the parameters of the operation;

² United States Space Priorities Framework, December 2021.

³ A Federal range is a launch site from which launches routinely take place that is owned and operated by the U.S. Government.

- Public safety analyses by FAA's Office of Commercial Space Transportation;
- Analyses to determine the impact on the NAS by the Air Traffic Organization and affected air traffic facilities;
- The FAA Command Center in Warrenton, VA, making decisions regarding the space operation, such as determining how long airspace must be closed during a nominal and off-nominal event; and
- Adjusting operations to mitigate the impact on other NAS users. This includes planning potential traffic management initiatives to balance system demand and system capacity and, within 48-72 hours of an operation, informing airspace users of restrictions via a Notice to Air Missions (NOTAM).⁴

Figure 1. Commercial Spaceflight Pre-Mission Planning Process



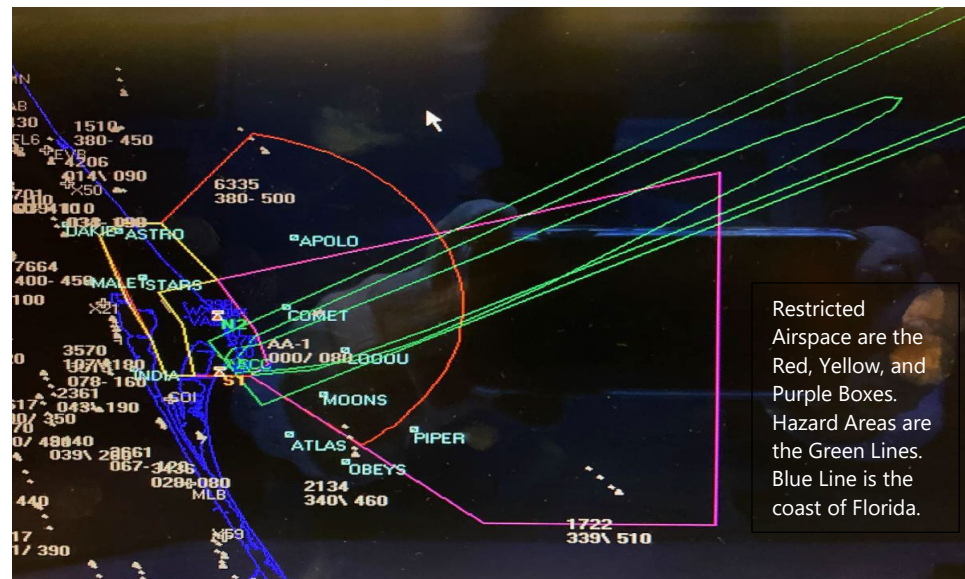
Source: FAA

During a commercial space launch or reentry, controllers clear the impacted airspace of all unauthorized air traffic prior to the scheduled launch or reentry time. Currently, FAA employs airspace segregation to protect other NAS operators during launch and reentry operations. As shown in figure 2, airspace segregation involves the closing of airspace and restricting its use to a specific

⁴ A NOTAM is a notice containing information essential to personnel concerned with flight operations but not known far enough in advance to publicize by other means. It states the abnormal status of a part of the NAS, not the normal status.

user—in this case, a commercial space launch or reentry operator—impacting all other aircraft regardless of their flying altitude. In addition, controllers establish temporary aircraft hazard areas⁵ to further define specific airspace that is closed during space launch or reentry operations and how air traffic will be rerouted around the closed airspace. FAA takes these measures in the event a launch or reentry operation concludes in a catastrophic failure and when a launch or reentry requires a planned jettison of vehicle hardware.⁶

Figure 2. Example of Restricted Airspace and Hazard Areas off the Coast of Cape Canaveral During a Commercial Space Launch



Source: Department of Defense

Results in Brief

FAA has deployed an SDI prototype, but its effectiveness in providing launch and reentry data to stakeholders is limited.

FAA began the SDI program in 2014 as a concept research project and implemented an operational prototype, known as the SDI Minimum Viable

⁵ Aircraft hazard areas identify locations that could potentially contain falling debris from a launch or reentry vehicle that would be hazardous to aircraft along a space launch or reentry vehicle's projected flight path.

⁶ A planned jettison occurs when a launch and reentry vehicle climbs under rocket power and its hardware, such as spent stages, fairings, and other components, are intentionally discarded and fall through the airspace to the surface.

Product,⁷ at the Command Center on June 30, 2021. However, SDI receives data from only one commercial space operator, SpaceX, who currently represents the majority of space missions. While the system is connected to two additional operators' systems, Blue Origin and Pacific Spaceport Complex Alaska, these connections were still in the testing phase as of September 2022. Also, FAA originally planned to install SDI at impacted air traffic facilities. However, FAA stated that the Agency only installed it at the Command Center due to the need to more quickly enable use of SDI's data and because installing a standalone system at all air traffic facilities would not be operationally efficient. As a result, SDI's data is only accessible by the Command Center's Space Operations group, with FAA's air traffic facilities and other NAS users receiving SDI information by telephone. The lack of direct access to the system's data prevents all affected stakeholders from receiving near real-time information regarding the status of a commercial space operation, hampering their ability to adjust their operations accordingly. This limited deployment is intended to be temporary in light of FAA's plans for a successor program—part of which will disseminate the space data to the field facilities on existing air traffic primary displays, such as the En Route Automation (ERAM) system.⁸ However, FAA has delayed its planned Final Investment Decision⁹ for the new program by 5 years, from September 2022 to September 2027. The Agency attributes this delay mainly due to budgetary considerations and because the Agency is refining the requirements for the successor program, including the impacts on other air traffic systems. Once FAA approves the program's requirements, it anticipates incorporating the capabilities into the existing NAS display systems in the fiscal year 2028 through 2032 timeframe. Until this is completed, FAA will be limited in its ability to integrate additional commercial space operations within existing NAS operations.

Although FAA is engaging with industry and other stakeholders, challenges remain to safely and efficiently integrate commercial space operations into the NAS.

As commercial space operations increase in number and complexity, it will become increasingly difficult to minimize their disruption to the NAS. FAA has created several committees and working groups as forums for stakeholders to provide input and recommendations on how to safely and efficiently integrate such operations. However, FAA has only taken limited steps to address identified barriers and recommendations, in part because the Agency is still in the early stages of developing and implementing concepts, procedures, and plans. For

⁷ For SDI, the term Minimum Viable Product was developed internally by FAA as the minimum set of features needed to make the system provide benefits to NAS operations.

⁸ ERAM is the computer system that processes flight and surveillance data and generates display data for air traffic controllers. The system is used to control high-altitude operations at FAA's 20 Air Route Traffic Control Centers.

⁹ A Final Investment Decision is the point where FAA decides whether it will approve, establish, and fund a proposed investment initiative.

example, in May 2020, FAA developed a Concept of Operations for managing commercial space traffic that identified 17 shortfalls within the current system, such as the limited ability to disseminate launch and reentry data, and corresponding strategies to address them. However, FAA officials stated they were only part of a preliminary analysis, and they are currently being updated and prioritized but may not be finalized until late 2023 or 2024, at the earliest. In addition, space launches and reentries can significantly impact air traffic along busy air corridors, such as Cape Canaveral, where FAA controllers often have to re-route commercial air carrier and other air traffic away from Florida's east coast inland over the central part of the State. While FAA has taken initial steps to mitigate these impacts on NAS users, such as implementing new launch procedures, more work in collaboration with industry remains to fully address them. Further, FAA has not determined the impacts that increased commercial space operations have on the en-route air traffic facilities responsible for supporting these operations, including their impact on controller workload. Finally, as the commercial space industry matures, FAA will be challenged in determining the appropriate level of regulatory oversight for this growing and more complex industry.

We are making recommendations to improve FAA's ability to provide and capture information regarding its efforts to integrate commercial space operations.

FAA Deployed an SDI Prototype, but Its Effectiveness Is Limited, and FAA Has Not Made Key Program Decisions

FAA deployed an SDI prototype in 2021, but its effectiveness in providing launch and reentry data to stakeholders is limited because it only receives data from one operator, only tracked one launch at a time until recently, and is only installed at the Command Center. Additionally, FAA has not finalized plans and requirements for a successor program intended to leverage the SDI prototype. The Agency is not expected to make a Final Investment Decision regarding this new program until September 2027, with the intention of gradual implementation through fiscal year 2032.

FAA Deployed an SDI Prototype, but Its Effectiveness Is Limited

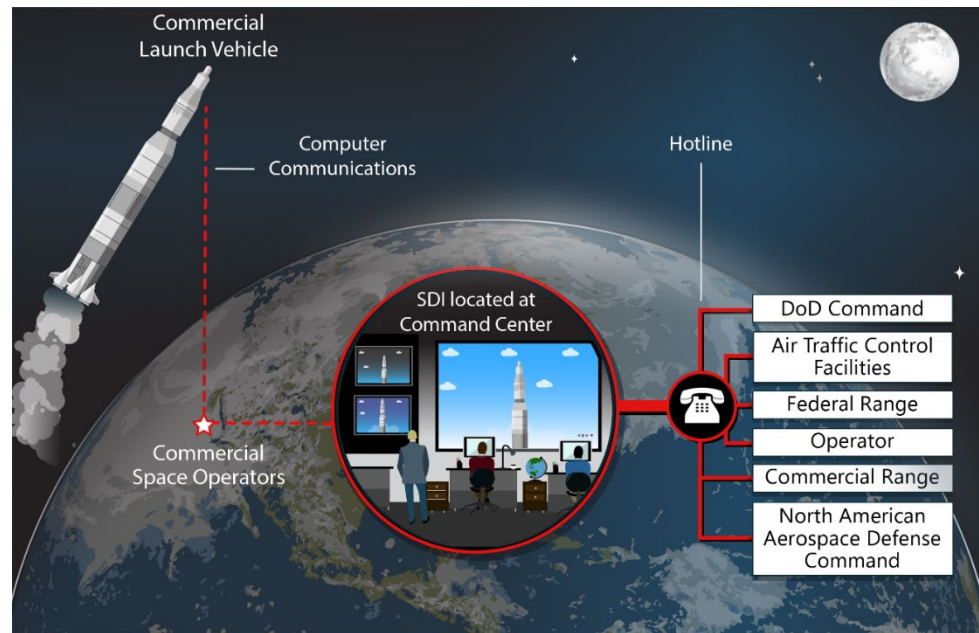
FAA began the SDI program in 2014 as a concept research project with a demonstration and implemented an operational prototype, known as the SDI Minimum Viable Product, at the Command Center on June 30, 2021. FAA considers the system a starting point for collecting near-real time launch and reentry data from a commercial space launch and reentry operator's vehicle.

As shown in figure 3, the SDI prototype is an operational system that processes vehicle launch and reentry data from operators and distributes it to the Agency's Traffic Flow Management System (TFMS).¹⁰ The ATO Space Operations Group¹¹ at the Command Center then uses these data to track a commercial space vehicle's actual trajectory against its planned trajectory during launch and reentry operations, a mission's event status, and the display of aircraft hazard areas. FAA personnel also relay this information by a telephone link, known as the Hotline, to impacted air traffic facilities, the Department of Defense (DoD), and other entities to provide near real-time situational awareness regarding the commercial space operation.

¹⁰ TFMS is a decision support tool and primary display for Traffic Management Units for supporting the management and monitoring of national air traffic flow. It processes available data sources, such as flight plans and departure and arrival messages, to maintain near real-time situational awareness and predict airspace areas that may experience congestion due to capacity reductions or unusual demand increase. The data from the SDI prototype is processed through the TFMS separately from the Hotline before being disseminated to stakeholders via the Hotline.

¹¹ ATO Space Operations Group is a team of FAA specialists from the Air Traffic Organization System Operations group working collaboratively with launch and reentry operators on a mission-by-mission basis.

Figure 3. Process for How Commercial Launch Vehicle Data Is Distributed Through the SDI System



Source: OIG analysis of FAA information

According to FAA, implementing SDI increases overall efficiency and situational awareness associated with commercial space launches and reentries. It also improves airspace management, according to FAA, by allowing the Command Center to act on data to support Time Based Launch Procedures¹² and Dynamic Launch and Reentry Windows,¹³ which were implemented in August 2020 and help open airspace faster after a commercial space operation.

However, SDI's current effectiveness in improving launch and reentry situational awareness is limited in large part because it is only receiving data from one commercial space operator—SpaceX, which represents the majority of current space missions. Two additional operators conducting missions, Blue Origin and Pacific Spaceport Complex Alaska, were still in the testing phase as of September 2022. According to FAA officials, the Agency is working with one operator on resolving data encryption issues, and there is not a target date for

¹² Time-Based Launch Procedures use existing capabilities within the TFMS to more efficiently identify aircraft projected to enter a launch or re-entry hazard area when space operations occur. They are used in conjunction with appropriate traffic management Initiatives to minimize the impact these operations have on aircraft traveling in impacted areas of the NAS.

¹³ Dynamic Launch and Re-Entry Windows focus on reducing aircraft hazard area durations through increased communication between space operators, launch and reentry site operators, and the Air Traffic Organization to gain more certainty as to when a space launch or reentry operation will occur.

completing testing with either operator, in part due to the lack of a mandate for submitting data to the Agency.

Other operators¹⁴ have yet to use the system because they either do not have the technology to submit the data or have a limited number of commercial space operations. Also, some FAA and industry officials indicated that even if operators had the technology to submit data for SDI, some may be reluctant to do so because they fear disclosing proprietary information. According to FAA officials, while the Office of Commercial Space Transportation approached several operators to participate in the program, they stated that it was cost prohibitive and that they would only participate if FAA provided funding to implement the connection, which the Agency did not provide. Yet, based on our work, other users, like the airlines, would use the information to adjust their operations. Also, initially the SDI system could only track one commercial launch at a time. FAA officials indicated that including concurrent mission capabilities was a priority for the SDI program and deployed this capability in April 2023.¹⁵

In addition, the system is only installed at the Command Center, and its data is only accessible by the Command Center's Space Operations group. While FAA's air traffic facilities, commercial space operators, and other Government users receive SDI information over the Hotline, this information is not available to other external NAS users, such as commercial air carriers.¹⁶ During an interview with a representative at a FAA air traffic facility, an FAA official indicated that they were not aware of SDI until we mentioned it. FAA officials we spoke with, including those at one air traffic facility, noted that a version of the SDI capability was initially installed several years ago for demonstration and research at this facility but was not connected to operational systems and did not have any live data to share, and the Air Traffic Organization subsequently removed it.

According to FAA representatives associated with the SDI program, the Agency determined that facilities did not need a separate SDI display or system at air traffic facilities in support of commercial space launches. They added that a separate display would not be as effective for users as integrating space data into controllers' primary displays in part because users would have to still transpose and manually update the data. The lack of direct access to the system's data prevents affected stakeholders from accessing near real-time information

¹⁴ There are 13 operators, including Blue Origin, Virgin Galactic, and Northrup Grumman, as well as the U.S. Space Force, in this group.

¹⁵ As of April 11, 2023, there have been nine instances where concurrent commercial launches occurred in the United States on the same day. These launches did not occur at the same location.

¹⁶ Sharing real-time spaceflight data with NAS users was one recommendation made by the Airspace Access Priorities Aviation Rulemaking Committee in 2019. See Exhibit D, recommendation 11 for the status of this recommendation.

regarding the status of a commercial space operation, limiting their ability to adjust their operations accordingly.

FAA Has Not Finalized Plans and Requirements for a Successor Program to SDI

According to FAA officials, the SDI Minimally Viable Product is temporary and the Agency plans to incorporate the system capabilities into the NAS Space Integration Capabilities (NSIC) program. This program would integrate SDI data and other capabilities into existing air traffic systems, including ERAM, Standard Terminal Automation Replacement System (STARS),¹⁷ and TFMS systems, giving air traffic personnel real-time launch and reentry data and improving situational awareness at both the Command Center and impacted air traffic facilities (see table 1).

Table 1. Potential NSIC Capabilities and Users Under Consideration by FAA

Potential Capabilities	Description	Potential Users
Integrated Hazard Area Information	Used to segregate aircraft from hazardous airspace	Command Center Space Operations group, Air Traffic Facility Traffic Management Units, and En-Route and Terminal Air Traffic Controllers
Live Launch/Reentry Vehicle and Mission Information	Support mission monitoring for situational awareness	Command Center Space Operations Group and Air Traffic Facility Traffic Management Units
Hazard Mitigation Decision Support	Identifies potential aircraft-to-hazard area/restricted airspace conflicts largely by leveraging existing functionality	En-Route Air Traffic Controllers

Source: FAA

¹⁷ STARS is a mission-critical NAS operational system used by controllers to provide air traffic control services to aircraft in terminal areas. Typical services the system allows controllers to provide include separating and sequencing air traffic, providing traffic alerts and weather advisories, and radar vectoring for departing and arriving traffic.

During our site visit to the Jacksonville en-route center, facility personnel stated having this information would allow them to better manage operations. For example, controllers currently have to key-in launch and reentry hazard areas on their radar displays while controlling air traffic at the same time, dividing the controllers' attention. Integrating these hazard areas onto controllers' radar scopes would eliminate this process and allow controllers to focus on separating air traffic.

FAA is working to refine the requirements for the NSIC program, including the impacts on other NAS systems such as ERAM and STARS. Without the refined requirements, FAA is not able to determine the costs and schedule for the program. In addition, the Agency has also delayed its planned Final Investment Decision for the program by 5 years, from September 2022 to September 2027. As we have reported over the years, determining and finalizing requirements for new systems and other modernization programs has been a longstanding issue for FAA that has led to cost overruns and delays in deploying new systems.¹⁸ FAA's reasons for delaying the Final Investment Decision for the NSIC program include:

- **Budget considerations.** Initially, FAA delayed the program's future deployment schedule due to the COVID-19 pandemic. According to FAA officials, this resulted in an Agency-wide decision that all current systems with planned enhancements, including those associated with the NSIC program that had not received a Final Investment Decision, be delayed by 1 year. Also, in January 2023, FAA officials informed us of further delays due to the Agency's overall prioritization of its capital investments, including Agency-wide adjustments that significantly reduced the program's projected funding levels by 50 to 90 percent per year for fiscal years 2024 through 2026.
- **Coordination.** Other program offices, including the ERAM, STARS, TFMS/Flow Management Data and Services (FMDS),¹⁹ and System Wide Information Management (SWIM) programs,²⁰ needed additional time to coordinate their planned schedules with the NSIC program along with other commitments already in development.

¹⁸ See *Total Costs, Schedules, and Benefits of FAA's NextGen Transformational Programs Remain Uncertain* (OIG Report No. AV2017009), November 10, 2016, and *FAA Has Taken Steps To Advance the SENSr Program, but Opportunities and Risks Remain* (OIG Report No. AV2019050), April 23, 2019. OIG reports are available on our website at <http://www.oig.dot.gov/>.

¹⁹ FMDS will replace the current TFMS system with upgraded infrastructure (hardware, software, and applications) and additional capabilities. FAA is in the process of seeking industry input into the future FMDS system.

²⁰ SWIM is a NAS-wide information system that offers a single point of access for aviation data, with producers of data publishing it once and users accessing the information they need through a single connection.

- **Establishing a Space Integration Collaborative Work Group with air traffic controllers to validate the program’s requirements.** FAA officials indicated there was a delay in establishing this group, which caused a delay in supplying operationally validated requirements to these programs. While the workgroup began meeting remotely starting in September 2021 to begin refining the requirements, it did not start work on validating the requirements until June 2022.

Until FAA makes the Final Investment Decision, Agency officials informed us that FAA will maintain the current SDI and that some enhancements, such as tracking dual launches simultaneously, are still planned for the system. Once the NSIC program requirements are approved, FAA anticipates incorporating the capabilities into the existing NAS systems in fiscal year 2028 through 2032 timeframe. FAA will also have to develop procedures and training for air traffic controllers and other personnel to use these capabilities. Until FAA completes these steps, and if commercial space operations increase as projected, the Agency will be limited in its ability to better integrate additional commercial space operations with existing NAS operations.

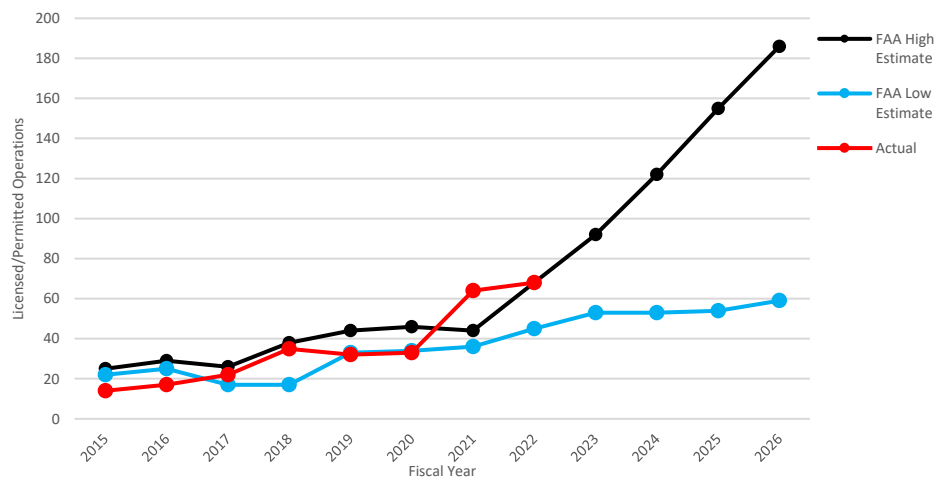
FAA Is Working With Commercial Space and Aviation Stakeholders but Faces Challenges To Successfully Integrate Commercial Space Operations

As commercial space operations increase in number and complexity, it will become increasingly difficult to minimize their disruption to the NAS. FAA has connected with stakeholders to provide input on commercial space integration issues and implemented some recommendations from those stakeholders, but has postponed taking action on other identified shortfalls and recommendations pending actions to finalize requirements for and make decisions on implementing the now-delayed NSIC program. Also, while FAA has implemented procedures aimed at reducing the amount of time commercial space operations impact NAS airspace, the Agency faces operational and policy challenges to efficiently integrate these operations.

Growth in Commercial Space Operations Presents Significant Integration Challenges

According to FAA, there were 74 licensed commercial space operations in fiscal year 2022, doubling the number of operations from 2 years prior. These operations have been predominantly unmanned, not human spaceflight. The Agency, noting the increased use of reusable vehicles and the expectation for increased human space exploration, estimates that the number of licensed operations will further increase by anywhere from 31 to 174 percent between fiscal years 2022 and 2026 (see figure 4). This expected increase in space activity is echoed by the U.S. Space Force (Space Force),²¹ which in February 2020 noted that over the subsequent 20-year period, the U.S. commercial launch industry was on the cusp of a 300 to 500 percent increase in launch rates.²²

Figure 4. Actual and Projected Growth in FAA Licensed and Permitted Commercial Space Operations



Source: OIG analysis of FAA data

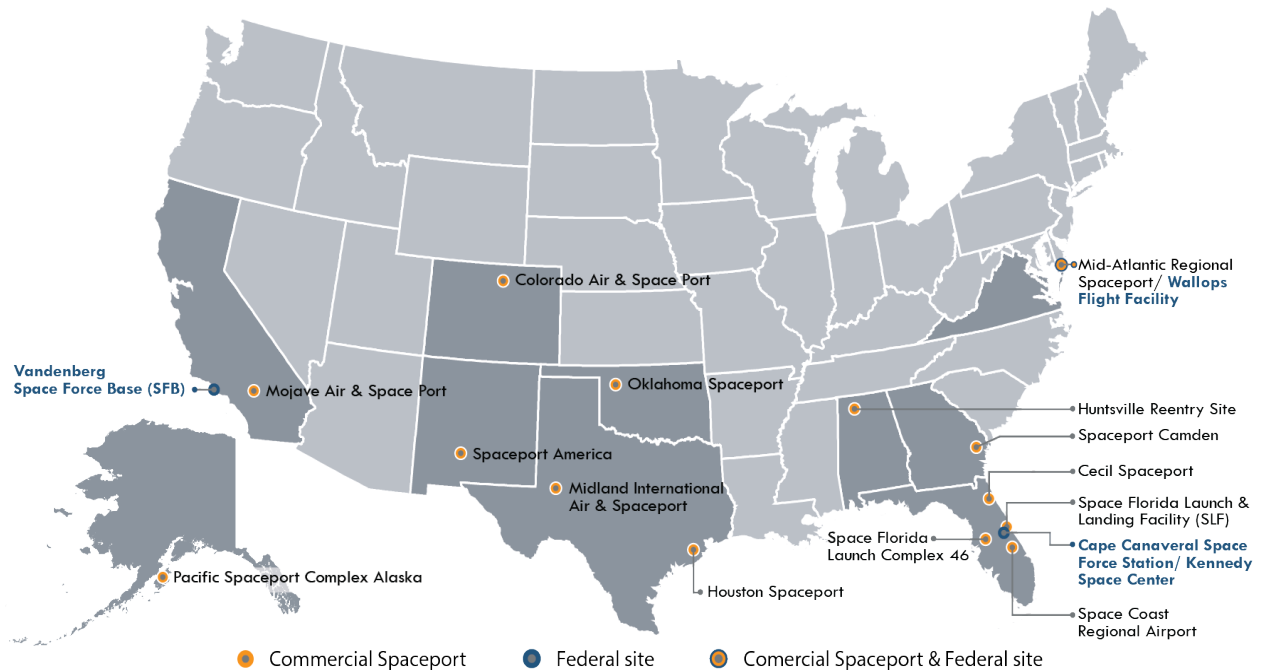
Currently, FAA has licensed 14 commercial spaceports (see figure 5). However, at least nine new launch sites are being proposed, including multiple locations in

²¹ The U.S. Space Force is a separate and distinct branch of the armed services, organized under the Department of the Air Force. Its mission is to organize, train, and equip space forces in order to protect U.S. and allied interests in space. Space Force procures many of its launches from commercial space operators and has identified a need to leverage more commercial capabilities.

²² *U.S. Space Force Range of the Future 2028 Strategic Intent*, February 2020.

Texas and Florida, and State governments are proposing incentives to have new spaceports built in their jurisdictions.

Figure 5. FAA-Licensed Spaceports



Source: FAA

In addition, Space Force is planning actions to support launch needs by converting its ranges to enable simultaneous support of multiple users and various operations. Space Force officials also recognized that this growth will create challenges in managing its operations, including whether it will have adequate lead time to service multiple launches in a day.

This anticipated increase in activity will further disrupt traffic flows for other airspace users, likely increasing the operational impacts and financial costs that aviation industry officials state these operations have on other NAS users. To illustrate this point, in 2019, Airlines for America, an interest group that represents many commercial airlines, noted that a single February 2018 space launch resulted in 429 aircraft being rerouted, with an average increase of 124 nautical miles flown, 523 gallons of fuel burned, and 18 minutes of flight time per aircraft. In 2021, it also pointed out that the Agency's final rule streamlining its commercial space licensing regulations²³ would result in a 50 percent increase in launches in the subsequent 10-year period over FAA's fiscal year 2021 forecast.

²³ *Streamlined Launch and Reentry License Requirements*, finalized on December 10, 2020, effective March 21, 2021.

This would result in an additional \$99 million in costs to other NAS users over the same timeframe.²⁴

FAA Has Created the Means To Collaborate With Stakeholders in Identifying Integration Issues, but the Agency Faces Challenges Implementing Solutions

FAA has created several external and internal committees and working groups as forums for commercial space, aviation, aerospace, internal Agency, and other stakeholders to provide input on commercial space issues (see table 2). These groups range from permanent advisory forums to one-time committees that have addressed specific aspects of commercial space.

Table 2. Examples of FAA Commercial Space Committees and Working Groups

Committee/Working Group	Purpose	Members
Commercial Space Transportation Advisory Committee (COMSTAC)	Meets bi-annually to provide FAA with information, advice, and recommendations regarding critical matters concerning the U.S. commercial space transportation industry.	Representatives from the commercial space, aviation, and aerospace industries; state governments; academia; space advocacy and other related industry organizations.
Airspace Access Priorities Aviation Rulemaking Committee (ARC)	A one-time committee established in November 2017, the ARC provided (1) recommendations for criteria that may be used to ensure equity in considering competing airspace access requests and accommodating operations on a diverse group of operators with widely varying flight systems, and (2) input on improved capabilities to manage the airspace, including tools, operational practices, and where necessary, policies, to minimize potential airspace conflicts.	Representatives from commercial, business, and general aviation; space operations; airports; spaceports; unmanned aircraft system operations, and balloon operations. In addition, representatives from DoD, the National Aeronautics and Space Administration (NASA), MITRE Corporation (MITRE), and National Air Traffic Controllers Association (NATCA) attended as observers.

²⁴ *Comments of Airlines for America on DOT’s Regulatory Review*, June 4, 2021.

Committee/Working Group	Purpose	Members
Air Traffic Organization (ATO) Space Collaborative Decision Making Forum	Provides industry and government stakeholders with a venue to exchange information and discuss issues related to integrating space and air operations to maximize NAS access.	Stakeholders including commercial space and aviation representatives.

Source: OIG analysis of FAA information

FAA is also funding outside research in areas related to commercial space safety and operations. This included the Centers of Excellence for Commercial Space Transportation, which is comprised of 10 member universities and their industry partners who conduct research in areas such as aerospace access and operations, aerospace vehicles, human operations and spaceflight, as well as industry innovation.²⁵ In addition, MITRE is conducting research on behalf of FAA in areas such as simulating how long it takes aircraft to evacuate hazard areas, developing a testbed so space launch or reentry operators can make data-driven decisions, and conducting modeling for integrating operations across air and space.

Through these groups and other means, FAA has worked internally and with the commercial space, aviation, and aerospace industries to identify shortfalls and make recommendations regarding integrating commercial space operations. FAA has taken action to address nearly half of the recommendations from an industry rulemaking committee, such as establishing procedures that allow for sharing of information between FAA and space launch and reentry operators. However, to date, FAA has not taken action to address additional identified shortfalls and remaining recommendations raised in these workgroups and other forums. This is due in large part to the Agency being in the early stages of developing concepts and plans related to integrating commercial space operations. For example:

- In May 2020, FAA published the Concept of Operations, which is viewed as the Agency's foundational document for managing the integration of commercial space launch and reentry operations in the mid- to long-term. Developed in collaboration with representatives from the Air Traffic Organization and Offices of NextGen and Commercial Space Transportation, it identified 17 shortfalls within the current system and corresponding strategies to address them. These shortfalls included a limited ability to disseminate launch and reentry data; a lack of policies regarding safety critical and non-critical events; and technical limitations, such as a limited ability to track commercial space and other aircraft in

²⁵ FAA ended the Centers for Excellence for Commercial Space Transportation program in August 2022.

real time. According to aviation stakeholders we interviewed, the document does a good job identifying the barriers for successfully integrating commercial space operations.

However, FAA has not taken action to address these shortfalls. According to FAA officials, these shortfalls were only part of a preliminary analysis used to inform the Concept of Operations and other Agency programs and projects. They indicated that the Agency is updating and prioritizing the shortfalls and is dependent upon publication of the Air Traffic Organization's NAS Integration of Transiting Operations (NITRO) strategy,²⁶ a new corporate action plan to identify and organize activities necessary to integrate space and other emerging higher altitude airspace operations. Once FAA approved the plan, which occurred in April 2023, the Agency stated that it would then validate, update, and prioritize the shortfalls as part of its NSIC program. However, FAA may not finalize these changes until late 2023 or 2024, at the earliest.

- FAA tasked the Access Priorities ARC with developing recommendations for criteria that would ensure equitable access to airspace for all users of the NAS, including commercial space launch and reentry operators. In August 2019, the ARC made 14 recommendations that are intended to enhance communication, data sharing, and collaboration between FAA and airspace users, and allow for more efficient optimization and utilization of the NAS through enhanced tools and capabilities. Additionally, the recommendations are intended to improve the integration of operations into the NAS in the near-term, with the insights gained to inform future integration of new entrants.

As of November 2022, FAA has fully implemented 6 of the 14 recommendations, including creating joint government/industry advisory committees, implementing the SDI prototype, and establishing procedures that allow for sharing of information between FAA and space launch and reentry operators. FAA has not completed 5 of the 14 recommendations in large part because they are dependent on implementation of the NSIC program. For example, one recommendation calls for implementing decision support tools in the automation systems used by air traffic controllers and managers. However, FAA is still deciding which of these tools to include as part of the NSIC program, where, as described above, the timeline for a Final Investment Decision has been postponed by 5 years until 2027. The remaining three recommendations

²⁶ The NITRO strategy involves implementing operational and other priorities in the short- to medium-term timeframe that will allow for the safe integration of upper airspace aviation and space launch and reentry vehicle operations into the NAS.

either require additional research or follow up from rulemaking committees that, according to FAA, will not commence until after a moratorium on commercial human space regulations is lifted,²⁷ which could occur as early as 2023. (See exhibit D for a list of the 14 ARC recommendations and OIG's assessment of their status.)

Overall, commercial space launch and reentry operators, aviation, and aerospace stakeholders indicated that FAA does a good job of engaging with industry to discuss commercial space issues. For example, in response to the ARC recommendations, FAA established a collaborative decision executive steering committee in June 2021 that includes FAA, commercial space, and aviation stakeholders to advise the Agency on airspace access and integration issues. Stakeholders we interviewed stated that the initial interactions have already helped to improve communications between the commercial space and aviation sectors in areas such as understanding how launches impact each side's operations. In addition, some stakeholders pointed out that the Agency could make improvements in how it coordinates and communicates internally with regards to commercial space operations and issues. Specifically, these stakeholders noted the two main offices responsible for overseeing commercial space issues, the Office of Commercial Space Transportation and Air Traffic Organization, have different missions and sometimes did not talk with each other regarding issues affecting operators. We note that FAA has taken steps to increase communications internally, including having weekly meetings between the two offices to discuss space operations and related issues.

Stakeholders also discussed additional steps that the Agency could take to further integrate commercial space operations. This includes developing and implementing additional procedures and plans related to commercial space operations and providing operators with more timely real-time information regarding these operations.

FAA Has Implemented New Procedures To Manage Commercial Space Launches but Continues To Face Operational and Policy Challenges

FAA has implemented launch and air traffic control procedures to improve efficiencies and is in the early stages of developing concepts and plans for integrating commercial space operations. However, FAA has not determined the

²⁷ In 2004, as part of the Commercial Space Launch Amendments Act, Congress imposed a moratorium on commercial human spaceflight regulations that has been extended several times and now continues through 2023.

impact that increased commercial space operations have on air traffic facilities and, along with stakeholders, faces challenges in determining the appropriate regulatory oversight for this growing and more complex industry.

FAA Is Only in the Early Stages of Integrating New Procedures

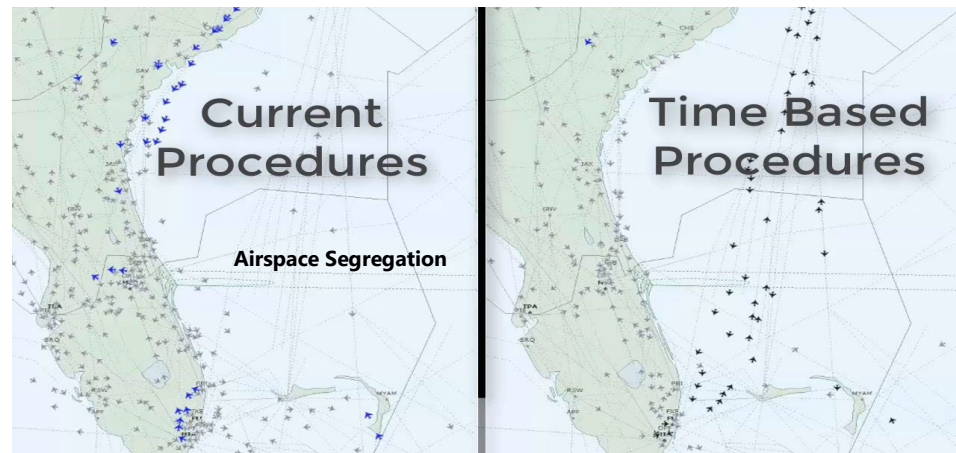
Space launches and reentries can significantly impact air traffic along busy air corridors. For example, when a space launch occurs at Cape Canaveral, commercial air carrier and other air traffic is sometimes routed from the east coast of Florida inland over the central part of the State. According to air traffic officials and commercial airline pilot representatives we interviewed, this can cause a bottleneck effect, impacting air traffic being controlled from major facilities as far away as the Washington and New York en-route centers, and cause ground delays at airports in airspace controlled at facilities as far away as the Chicago Center. In addition, officials at one center stated that once the airspace is reopened, it can take controllers 2.5 hours to return aircraft to pre-launch traffic flows.

FAA has implemented procedures aimed at reducing the amount of time it closes impacted airspace or adjusts normal NAS operations to accommodate commercial space launches and reentries. These include:²⁸

- **Time-Based Launch Procedures.** In conjunction with other traffic management initiatives, these procedures attempt to more efficiently identify aircraft projected to enter a launch or re-entry hazard area when space operations occur. This allows for reduced aircraft re-routing for space launch or reentry operations as compared to the normal practice of segregating airspace for longer periods of time. See figure 6 for an example of the operations along the coast of Florida, which shows aircraft re-routed inland with airspace segregation compared with those that are more efficiently routed over the ocean using time-based procedures.

²⁸ An FAA-produced video explaining the impact of Cape Canaveral space launches on the surrounding airspace, Time Based Launch Procedures, and Dynamic Launch and Reentry Windows can be found on FAA's [website](#).

Figure 6. Aircraft Routes Using Airspace Segregation vs. Time-Based Launch Procedures Along Florida Coast



Note: For current procedures, the blue dots represent aircraft whose operations are routed inland during space launches. Their normal route is over the Atlantic Ocean, which is allowed with time-based procedures.

Source: FAA

- **Dynamic Launch and Reentry Windows.** These procedures focus on reducing aircraft hazard area durations through increased communication between launch and reentry space operators, launch and reentry site operators, and the Air Traffic Organization to gain more certainty as to when a space launch or reentry operation will occur. According to FAA, it used this procedure for 46 of 63 space operations²⁹ completed in 2021, resulting in an average savings of nearly 148 minutes of nominal airspace closure time per operation.

In addition, given the projected growth of the commercial space industry, some stakeholders expressed concerns regarding whether FAA's current approach of segregating airspace to accommodate commercial space operations is effective. As activity increases and operators introduce new vehicle types, FAA will have to consider other options for integrating these operations, likely requiring procedural changes and new or updated technologies.

FAA is working with MITRE on high-level concepts to further integrate commercial space along with other higher-altitude aircraft into the NAS. In addition, it is developing the NITRO strategy to determine operational and other priorities it can implement in the short- to medium-term timeframe. However,

²⁹ While FAA reported 64 launches in fiscal year 2021, it only included 63 launches in the data provided to OIG regarding its use of Dynamic Launch and Reentry Windows.

they are both in the early phases of development, and FAA has not established timeframes as to when the Agency will implement them.

FAA Has Not Determined the Impact of Increased Commercial Space Operations on Air Traffic Facilities

Commercial space operations require local air traffic facilities, mostly at en-route centers, to provide operational and administrative support prior to, during, and after commercial space launch and reentry operations. This support includes developing and distributing launch packages, implementing aircraft hazard areas, publishing NOTAMs containing space launch details, closing and reopening airspace and re-routing aircraft, keeping aircraft out of restricted airspace, and following the status of the launch and reentry via the Hotline.

FAA air traffic managers and employees at the Florida facilities we visited expressed concerns about staffing challenges associated with supporting commercial space operations. These challenges include altering long-established schedules by rotating air traffic controllers and Traffic Management Unit personnel from previously planned shifts, scheduling overtime, and, when there is a midnight launch, scheduling an additional controller who would typically work another shift, making them ineligible to work their normal shift. Managers and employees stated that these issues can be compounded when there are back-to-back launches, military launches in conjunction with commercial space launches, and concurrent missions. Additionally, cancelled or “scrubbed” launches, which can occur until shortly before lift-off, require the same planning and staffing adjustments as successful launches. Once these launches are rescheduled, facilities must readjust schedules and redo administrative items, such as launch packages.

However, FAA has not conducted a comprehensive study or analysis examining the impacts that commercial space operations have on air traffic facilities, specifically en-route centers. We found that FAA directed the Miami and Jacksonville en-route centers to complete studies examining the impact that commercial space operations are having on their Traffic Management Units though.

In addition, the current en-route controller workload model, which MITRE calculates and is used to help determine controller staffing levels, only captures certain tasks that may indirectly relate to commercial space operations. The model does not directly account for how tasks associated with these operations impact a controller’s workload. In addition, the tasks used in the model to evaluate controller workload has not been updated since the fiscal year 2014–2015 timeframe, and therefore does not capture all the tasks that controllers currently perform. As a result, FAA is limited in determining whether it has the

appropriate personnel in place at the right locations to meet current and future operational needs.³⁰

FAA Faces Challenges Determining Appropriate Regulatory Oversight for a Growing Commercial Space Industry

While FAA is responsible for ensuring the safety of launch and reentry operations, there is a statutory moratorium prohibiting FAA from promulgating any new regulations governing human spaceflight until 2023. In addition, regulations governing commercial space vehicles are significantly different than those for civil aviation, and current law limits operators' liability for incidents involving space tourism. With the moratorium set to expire in 2023 and as the commercial space industry matures, FAA, other government stakeholders, and the commercial space, aviation, and aerospace industries will likely be discussing key policy questions, including to what extent FAA should further regulate the industry, whether any such regulation should be consistent or different across types of space operations, and how to balance safety and innovation priorities in connection with any such regulation.

Finally, airline and pilot association representatives noted that commercial space launch and reentry operators are not required to contribute to the Government's costs through the Airport and Airway Trust Fund.³¹ A commercial space industry representative did not have an opinion regarding whether commercial space operators should contribute, but noted that the aviation industry had decades of infrastructure paid for and grants prior to paying excise taxes.

Conclusion

The commercial space industry is a relatively new and rapidly growing segment of the aerospace industry. While FAA has introduced an initial system to improve integration of commercial space operations, it still faces key decisions regarding implementation of additional technologies to further improve the safety and efficiency of these operations. The Agency must also continue to work with the commercial space, aviation, and other aerospace industries to integrate commercial space operations into the NAS. This will require the Agency to provide accurate, up-to-date information regarding its efforts to implement

³⁰ This is similar to what the Government Accountability Office found in 2019, where the Office of Commercial Space was not projecting its workload beyond a two-year budget cycle, limiting its ability to plan for its longer-term workforce needs. See *Commercial Space Transportation: Improvements to FAA's Workforce Planning Needed to Prepare for the Industry's Anticipated Growth*, GAO, May 23, 2019.

³¹ The Airport and Airway Trust Fund consists of nine aviation excise taxes on passengers, cargo, and fuel that are used to finance FAA's annual capital budget and portions of its operations budget.

improvements discussed with stakeholders and to determine the resources needed to support commercial launch and reentry activities. Without taking these steps, FAA and its stakeholders may not have the information they need to make decisions regarding safely and efficiently integrating commercial space operations into the NAS.

Recommendations

To improve FAA's ability to provide and capture information regarding its efforts to integrate commercial space operations, we recommend that the Federal Aviation Administrator:

1. Update the commercial space operational shortfalls identified in the 2020 Concept of Operations, and report out on any changes to the shortfalls and plans for addressing them.
2. Update and publish the status of Aviation Rulemaking Committee recommendations that have not been implemented, including establishing target action dates for recommendations that are aligned with implementation of the National Airspace System Space Integration Capabilities program.
3. Determine the workload impact of commercial space operations at air traffic facilities, and take action as needed.
4. Identify the specific direct tasks associated with commercial space operations, determine if they should be included in the en-route controller workload model, and if so, incorporate them in the next updated model.

Agency Comments and OIG Response

We provided FAA with our draft report on April 27, 2023, and received its official response on May 26, 2023, which is included as an appendix to this report. FAA concurred with our four recommendations and provided appropriate actions and completion dates for recommendations 1 and 2. In addition, in subsequent email correspondence, FAA provided a target action date of December 31, 2024, to provide us with an update on its actions to address recommendations 3 and 4. Accordingly, we consider all recommendations resolved but open pending completion of the planned actions.

Actions Required

We consider recommendations 1 through 4 resolved but open pending completion of planned actions.

Exhibit A. Scope and Methodology

This performance audit was conducted between October 2021 and April 2023. We conducted this audit in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Our audit objectives were to assess (1) FAA's progress in implementing the SDI program and (2) actions taken and planned by FAA and the aerospace and aviation industries to integrate commercial space operations into the NAS. This report is in response to a request from the Ranking Members of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation.

The audit focused on FAA's implementation of the SDI program, its impacts on the current and future operation of the NAS, and how FAA and the aerospace and aviation industries are working together to integrate commercial space operations into the NAS. To assess FAA's progress in implementing the SDI program, we gathered information about the current status of the program, including where the system was implemented, how it is currently being used, and future plans for the current program and related programs, such as the NSIC program. We obtained and reviewed documentation, including program status reports, planning documents, the current SDI development contract, and Agency budget submissions, to determine the current and future status of the SDI and related programs. We met with FAA Air Traffic Organization and Office of Commercial Space Transportation officials, the contractor who developed the SDI, as well as representatives from DoD; NASA; NATCA; and the commercial space, aviation, and aerospace industries regarding their knowledge and views on the SDI and its use during commercial space operations. We visited or contacted the David J. Hurley Air Traffic Control System Command Center and five air traffic facilities, selected based on their proximity to commercial space launch activities and interaction with launch and reentry space operators and the Command Center during these operations. We also spoke with facility and NATCA personnel to determine whether and how the SDI is used.

To assess actions taken and planned by FAA and the aerospace and aviation industries to integrate commercial space operations into the NAS, we determined whether FAA had formed external and internal committees, working groups, and forums that examined commercial space integration issues. We also determined other actions the Agency has taken to study integration issues, such as funding academic and independent research. Through interviews and electronic

correspondence with FAA officials and document reviews, we ascertained FAA's progress on addressing the 17 shortfalls the Agency identified in its 2020 Concept of Operations document and evaluated its progress in implementing the 14 recommendations made by Airspace Access Priorities ARC in 2019. We also conducted interviews with FAA, NASA, DoD, and MITRE officials, along with representatives from the commercial space, aerospace, and aviation industries and related employee unions to ascertain their views on the current state of the commercial space industry, its efforts to integrate commercial space operations, and related issues, such as FAA's plans for addressing increasing commercial space operations, technological changes, and the need for further regulation of the industry.

In addition, we determined additional steps FAA had taken to integrate commercial space operations, such as implementing new procedures that impact NAS users during commercial space operations. While FAA provided data regarding how one procedure, Dynamic Launch and Reentry Windows, reduced the amount of time airspace was closed during commercial space operations, we did not test the validity of this data as it was not the focus of the audit. Finally, during our interviews with FAA and union representatives at the five air traffic facilities, we discussed the impact commercial space operations have on the facility's operations, its workforce, and the air traffic system as a whole.

Exhibit B. Organizations Visited or Contacted

FAA Headquarters Offices

Air Traffic Organization (ATO)

Program Management Office

Office of Commercial Space (AST)

FAA Field Offices

Albuquerque Air Route Traffic Control Center, Albuquerque, NM

David J. Hurley Air Traffic Control System Command Center, Warrenton, VA

Jacksonville Air Route Traffic Control Center, Hilliard, FL

Miami Air Route Traffic Control Center, Miami, FL

Orlando Terminal Radar Approach Control Facility, Orlando, FL

Palm Beach Terminal Radar Approach Control Facility, West Palm Beach, FL

Government Organizations

Department of Defense (DoD)

Space Launch Delta 45, Cape Canaveral Space Force Station, FL

National Aeronautics and Space Administration (NASA)

Industry Groups and Other Organizations

Advanced Sciences and Technologies

Aerospace Industry Association (AIA)

Airlines for America (A4A)

Air Lines Pilot Association (ALPA)

Commercial Spaceflight Federation (CSF)

National Air Traffic Controllers Association (NATCA)

The MITRE Corporation (MITRE)

Commercial Launch and Reentry Space Operators

Blue Origin

Space X Aerospace Company

Virgin Galactic

Exhibit C. List of Acronyms

ARC	Aviation Rulemaking Committee
AST	Office of Commercial Space
ATC	Air Traffic Control
ATO	Air Traffic Organization
CDM	Collaborative Decision Making
COMSTAC	Commercial Space Transportation Advisory Committee
DLRW	Dynamic Launch and Reentry Windows
DOD	Department of Defense
DOT	Department of Transportation
ERAM	En-Route Automation Modernization
FAA	Federal Aviation Administration
HRAM	Hazard Risk Assessment and Management
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NSIC	NAS Space Integration Capabilities
NOTAM	Notice to Air Missions
OIG	Office of Inspector General
SAA	Special Activity Airspace
SDI	Space Data Integrator
STARS	Standard Terminal Automation Replacement System
TBLP	Time Based Launch Procedures
TFMS	Traffic Flow Management System

Exhibit D. Status of the 2019 Commercial Space ARC Recommendations

ARC Recommendation to FAA	FAA Actions	OIG's Assessment of FAA's Implementation
1) Accelerate efforts to allow more efficient use of airspace needed for spaceflight operator.	<p>FAA has implemented several technologies and procedures that allow for more efficient use of airspace during space operations, including:</p> <ul style="list-style-type: none"> Procedures for integrating complex commercial space launch and reentry operations, which reduce airspace closure times and resulting delays for other NAS users; The ATO Space Operations Hotline, both internal to the FAA and with external stakeholders in the space and aviation industries, which also increase more rapid release of airspace. The new capabilities and procedures satisfy the recommendation at an initial level; improvements will continue as FAA adds stakeholders. The SDI operational prototype, deployed to the ATO Space Operations group in June 2021, provides near real-time vehicle information from launch operators and reduces manual data entry required ahead of a mission. It also allows the Space Operations group to share hazard area status changes in near-real-time to affected Traffic Management Units (TMU). In addition, a Final Investment Decision for the NSIC program, which will automate data sharing for near-real time hazard area status changes to Traffic Management Coordinators and air traffic controllers at affected facilities, is planned for 2027. 	FAA's steps have met the intent of the recommendation.

ARC Recommendation to FAA	FAA Actions	OIG's Assessment of FAA's Implementation
2) Within 30 days of submission of the ARC final report, establish a Steering Committee to advise FAA on policy and strategy regarding airspace access and integration.	In June 2021, the ATO formed the Space Collaborative Decision Making (CDM) Executive Steering Committee to advise the Space Collaborative Decision Making body and subgroups. The Space CDM group communicates and collaborates within FAA, industry, and other government stakeholders.	Forming the Space CDM Collaboration Forum and Executive Steering Committee meets the intent of the recommendation.
3) Within 60 days of submission of the ARC Final Report, establish a collaborative decision making-like space operations committee (including operators, DoD, and NASA) to recommend appropriate information to be exchanged with FAA for more dynamic airspace management and situational awareness and to help implement the details charted by the Steering Committee.	The Space CDM process was established with an initial meeting of the Executive Steering Committee in 2021 under Systems Operations Services and continues to evolve. The Executive Steering Committee Space Operations Committee has met and a sub-team was established on data/data exchange. The current focus is on key issues in dealing with data/data exchange. The group is comprised of representation from FAA and space stakeholders, such as launch and reentry operators, unions, and other government agencies. Other subgroups are under consideration and discussion by the Executive Steering Committee.	Forming the Space CDM Collaboration Forum and Executive Steering Committee meets the intent of the recommendation.
4) Implement the ability to create dynamic airspace areas on controller automation systems that can identify potential conflicts between airborne flight trajectories.	<p>ATO developed and implemented Time-Based Launch Procedures (TBLP) and Dynamic Launch/Reentry Window (DLRW) procedures for integrating complex commercial space launch and reentry operations into the NAS. TBLP and DLRW were introduced to reduce airspace closure times and resulting delays for other NAS users and reduce windows of time for potential conflicts.</p> <p>ERAM Build 2, FY2022 will deploy predefined hazard area information on controller displays (PVD Draw function).</p> <p>NSIC (Final Investment Decision 2027) will send static hazard area information (including near-real time hazard area status changes) to controller automation at appropriate en-route and terminal facilities.</p>	According to FAA, the ERAM Build 2 is scheduled to be released in September 2023. In addition, FAA is still making decisions regarding the NSIC program and its impact on automation systems. As a result, FAA is still in the process of implementing this recommendation.

ARC Recommendation to FAA	FAA Actions	OIG's Assessment of FAA's Implementation
5) Implement decision support tools in the automation systems for air traffic controllers and managers.	This recommendation is being addressed by several efforts, including the SDI Minimum Viable Product and NSIC. NSIC will provide enhanced situational awareness to ATO Space Operations and select field traffic management units. NSIC will extend en-route conflict probe functionality to identify aircraft-hazard area conflicts. Efforts are underway to identify the operational need for additional automation and support tools for ATO via the NSIC-E1 investment.	FAA is still making decisions regarding the NSIC program and its impact on automation systems.
6) Develop procedures and training to enable future automation capabilities.	Ongoing work includes initiation and refinement of technical training courses dealing with space operations and automation. Several training packages were developed for space launch/reentry and changes associated with it. Training is developed to support automation capabilities as capabilities and procedures change. AJT, in collaboration with AJR and other stakeholders, educates the air traffic community by developing educational sound bites on subject areas such as Debris Response Areas, TBLP, and DLRW and other space training items. These efforts will continue as further changes warrant.	FAA is still making decisions regarding the NSIC program and its impact on automation systems. As a result, it cannot develop procedures and training for related automation systems.
7) Implement a Hazard Risk Assessment and Management (HRAM)-like capability available to air traffic control to allow for dynamic airspace management.	The HRAM concept is in the research domain. NextGen further matured the dynamic hazard area concept and the underlying dynamic hazard generation technology (i.e., HRAM) in a demonstration with SpaceX. This research demonstration included the development of operational data requirements, Hazard Volume Generator Data Exchange Guidelines, human-machine interface considerations, and exploration of how the research results could potentially be incorporated into standard data exchange models. Further research is ongoing.	FAA is in the research phase with this concept and has yet to implement this recommendation.
8) Implement and enable an SDI-like capability that allows the industry to share telemetry data with air traffic control systems and should be deployed to process telemetry to be supplied to HRAM and other automation platforms as necessary.	This recommendation is initially satisfied by the SDI Minimum Viable Product operational prototype, June 2021, with interface to the TFMS; data is shared via TFMS. Operators are in progress to connect to the system.	FAA implemented the SDI Minimum Viable Product and, through the NSIC program, is examining how to include similar capabilities on to existing automation platforms. The Agency has met the intent of the recommendation.

ARC Recommendation to FAA	FAA Actions	OIG's Assessment of FAA's Implementation
9) Implement a NAS operational airspace utilization assessment for planning and post-analysis capability and make it available to operators online.	Internal FAA analysis tools used by ATO Space Operations personnel include the NAS Effects Analysis and Planning tool. FAA is working on other tools and information sharing mechanisms to make information sharing available to operators on-line.	FAA has not made these or similar tools available to operators. As a result, it has yet to implement this recommendation.
10) Implement a collaborative decision making-like process for providing advanced notification time prior to an event requiring special activity airspace (SAA).	FAA is actively working with DoD on issues surrounding SAA and has been for years. The Space CDM group will help to address this recommendation once the specifics have been worked out between the two federal agencies.	Steps taken by FAA have met the intent of the recommendation.
11) Ensure sharing of real-time spaceflight status, including readiness forecasts prior to flight, with other NAS users.	<p>The implementation of the ATO Space Operations Center Hotline, which is used to present real-time status to participants, has been a great benefit in addressing this recommendation. Additional operators and stakeholders are requesting participation.</p> <p>SDI is also addressing this recommendation with ATO Space Operations and space operators. NSIC potentially could extend real-time status to Traffic Management Centers at affected facilities.</p>	While air traffic facilities, DoD, and space operators have access to the Hotline, other NAS operators do not. FAA does advise NAS operators when airspace is released after a space operation is completed. In addition, FAA has not made decisions regarding how the NSIC program will extend real time information to other NAS users. FAA has partially implemented this recommendation.
12) Implement procedure updates for tactical information exchange between space operators and FAA regarding on-time operations to enable more dynamic airspace activation/deactivation.	The ATO has implemented DLRW procedures to assist in integrating complex commercial space launch and reentry operations into the NAS and enable more dynamic airspace activation/deactivation. During space launch and reentry operations, DLRW procedures focus on reducing hazard area durations by enabling increased operational awareness to air traffic controllers through improved data-sharing between space operators, site operators, and Air Traffic Control (ATC). ATC is able to gain a greater certainty as to when, within the launch or reentry window, the operation will occur, enabling a transition from strategic to tactical strategies that respond to actual conditions that can shorten the duration of time that airspace is reserved for the sole use of the space operator.	Due to implementation of the DLRW procedures as well as information exchanged over the Hotline, FAA has met the intent of the recommendation.

ARC Recommendation to FAA	FAA Actions	OIG's Assessment of FAA's Implementation
13) Mandated equipage for any operation should be accomplished through an established regulatory or other rulemaking process, and should not be implemented through ad hoc means, such as letters of agreement.	<p>Congress imposed a moratorium on FAA regulating the commercial human spaceflight industry until Oct. 1, 2023. No equipage mandates have been identified to date.</p> <p>AST, along with the COMSTAC, has proposed potential future Aerospace Rulemaking Committee actions if or when the moratorium expires and is proceeding with the assumption the moratorium will expire on October 1, 2023.</p>	Due to the moratorium, FAA has not convened a follow-on ARC.
14) Convene a future, follow-on ARC to further advise on measures to achieve full integration of the NAS.	Future ARC gatherings will be established as needed.	Due to the moratorium, FAA has not convened a follow-on ARC.

Source: OIG analysis

Exhibit E. Major Contributors to This Report

ROBIN KOCH	PROGRAM DIRECTOR
FRANK DANIELSKI	PROJECT MANAGER
MICHAEL BROADUS	SENIOR ANALYST
AIESHA MCKENZIE	SENIOR ANALYST
DEDRIC JACKSON	ANALYST
AUDRE AZUOLAS	CHIEF COMMUNICATIONS OFFICER
ALLISON DUKAVAS	WRITER-EDITOR
SETH KAUFMAN	DEPUTY CHIEF COUNSEL
SHAWN SALES	SUPERVISORY VISUAL COMMUNICATIONS SPECIALIST

Appendix A. Agency Comments



Federal Aviation Administration

Memorandum

Date: May 26, 2023

To: Nelda Z. Smith, Assistant Inspector General for Aviation Audits

From: Erika Vincent, Acting Director, Office of Audit and Evaluation, AAE-1

Subject: Federal Aviation Administration's (FAA) Response to Office of Inspector General (OIG) Draft Report: FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges

ERIKA S
VINCENT

Digitally signed by
ERIKA S VINCENT
Date: 2023.05.26
10:53:20 -04'00'

The FAA is taking a smart, agile approach to implementing system investments related to commercial space. We are pairing automation technology with improvements to procedures and policies to achieve near-term benefits while reducing risk and applying a conscientious investment strategy. As a result, the FAA has made significant strides in integrating space operations into the National Airspace System (NAS) by leveraging existing technology through procedural changes, as well as deploying and iteratively improving new technology. Through these changes, the FAA has reduced airspace closures by thousands of minutes by leveraging real-time hazard area release procedures, using time-based launch procedures, and introducing dynamic launch and reentry windows at all launch locations. Additionally, the Space Collaborative Decision Making (SpCDM) process was established in 2021 as a joint industry/government forum. The SpCDM group meets regularly as an open forum for stakeholder coordination and information sharing.

These advances have allowed us to evolve along with the space launch industry as it innovates and will continue to ensure the best technological solution. While the OIG points out that the current prototype has limited use, that reduced capability is part of the FAA's strategy which: 1) supports user acceptance; 2) mitigates risks; and 3) enables ongoing, agile discovery to support future operations more cost effectively. Deploying the Space Data Integrator (SDI) operational prototype was a planned foundational step to help inform future capabilities.

Counter to some of the statements in the report, the FAA has identified scope and functionality for the referenced successor program to the SDI, known as the NAS Space Integration Capabilities (NSIC). We are currently refining and maturing requirements, while aligning activities with the systems that will be taking in the requirements and aligning to those system schedules and timelines. The NSIC investment takes the applicable SDI data to the field facilities, leveraging existing automation systems. As a new software enhancement, the NSIC investment continues to be a part of the Agency's ongoing prioritization of capital investments.

The FAA has leveraged best practices throughout this process, such as following a methodical safety risk management plan and process to ensure safe and efficient integration capabilities of commercial space operations into the NAS. In addition, we have implemented a highly collaborative stakeholder management program and are highly engaged with all program stakeholders inside and outside of the FAA through a number of workgroups, committees, and communication channels.

Upon review of the draft report, we concur with OIG's four recommendations as written. We will implement recommendation 1 by February 29, 2024, and recommendation 2 by October 31, 2023.

For recommendations 3 and 4, FAA will need to complete a study to determine the workload impact of commercial space operations at air traffic facilities. The results of that study could be used to verify operational impacts and to determine if there is a need to update the controller workforce model to include commercial space operation related tasks.

We appreciate this opportunity to offer additional perspective on the OIG draft report. Please contact Erika Vincent at erika.vincent@faa.gov if you have any questions or require additional information about these comments.

Appendix B. Nongovernmental Organization Responses

The James M. Inhofe National Defense Authorization Act for Fiscal Year 2023³² (NDAA) requires our office to inform nongovernmental organizations and business entities (NGOs) when they have been specifically identified in an OIG non-investigative report. NGOs have 30 days to review our report and may submit a written response. In accordance with the NDAA, we will notify NGOs and include their responses when applicable as required. Any claims or statements made within are wholly attributable to the NGOs alone. Any information or conclusions they may contain were not subject to Generally Accepted Government Auditing Standards nor verification by the Office of Inspector General.

³² Pub. L. No. 117-263 (2022), Sec. 5274.

NATCA Comments on
DOT OIG Report on Commercial Space

To: U.S. Department of Transportation Office of Inspector General c/o Nelda Z. Smith,
Assistant Inspector General for Aviation Audits (via NGOResponses@oig.dot.gov)

From: National Air Traffic Controllers Association, AFL-CIO

Date: July 21, 2023

Re: DOT OIG Report: “FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges”

I. NATCA COMMENTS

The National Air Traffic Controllers Association (NATCA) was asked to review and provide comments on the U.S. Department of Transportation (DOT) Office of Inspector General’s (OIG) Report dated June 21, 2023, titled “FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges” (hereinafter “OIG Report”). That report – which was created pursuant to a request from the Ranking Members of U.S. House of Representatives Committee on Transportation and Infrastructure and Subcommittee on Aviation – examined the Federal Aviation Administration’s (FAA) Space Data Integrator (SDI) program and other actions taken by the FAA and the aerospace industry related to commercial space integration. The report states that OIG’s objectives were assess “(1) FAA’s progress in implementing the SDI program and (2) actions taken and planned by FAA and the aerospace and aviation industries to integrate commercial space operations into the NAS.”

As a part of the audit, NATCA’s national representative for commercial space, Paul Behan, was a regular participant and attended site meeting at Miami Air Route Traffic Control Center (ZMA), Jacksonville Air Route Traffic Control Center (ZJX), and at the Central Florida Terminal Radar Control Facility (F11).

Although the report accurately reflects the current state of the system, as well as the tools needed for controllers in air traffic facilities to move toward integration, NATCA was disappointed that none of the recommendations addressed the need for (1) a stable and sufficient funding stream necessary to make commercial space integration a near-term reality; and (2) expedited development and deployment of commercial space integration tools and related investments so that the frontline workforce has what it needs for long-term success and sustainability. As a result, despite accurately reflecting the current state of affairs, ultimately, the report misses an opportunity to affect tangible change by not including recommendations in these areas.

Above and beyond these high-level concerns, NATCA also provides the following specific feedback on inaccuracies within the report:

A. Inaccurate Statement on Accessibility of Information Generated by FAA's Space Data Integrator

On page 6, in discussing the limited effectiveness of an SDI prototype, the report states:

FAA originally planned to install SDI at impacted air traffic facilities. However, FAA stated that the Agency only installed it at the Command Center due to the need to more quickly enable use of SDI's data and because installing a standalone system at all air traffic facilities would not be operationally efficient. As a result, SDI's data is only accessible by the Command Center's Space Operations group, with FAA's air traffic facilities and other NAS users receiving SDI information by telephone. The lack of direct access to the system's data prevents all affected stakeholders from receiving near real-time information regarding the status of a commercial space operation, hampering their ability to adjust their operations accordingly.

OIG Report at 6 (emphasis added). This statement is inaccurate. Air traffic facilities do not receive information by telephone that is produced by the SDI program.

B. Inaccurate Statement on Pacific Spaceport Complex Alaska

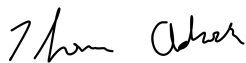
On Page 9, in discussing the limited deployment and effectiveness of the SDI Prototype, the report states:

However, SDI's current effectiveness in improving launch and reentry situational awareness is limited in large part because it is only receiving data from one commercial space operator—SpaceX, which represents the majority of current space missions. Two additional operators conducting missions, Blue Origin and Pacific Spaceport Complex Alaska, were still in the testing phase as of September 2022.

OIG Report at 9 (emphasis added). This statement also is inaccurate. Pacific Spaceport Complex Alaska (PSCA) is a launch site, but not a launch operator. To the best of NATCA's knowledge, Although PSCA may be working toward improving their infrastructure by experimenting with ways in which a tenant can transmit data, currently PSCA does not have a launch operator at PSCA that has agreed to share data.

Dated: July 21, 2023

Respectfully submitted,



Thomas Adcock
Director of Safety & Technology



Gregory R. Shoemaker, Esq.
Senior Counsel for Policy

U.S. Department of Transportation
Office of Inspector General

Fraud, Waste, & Abuse

 **Hotline**

www.oig.dot.gov/hotline

hotline@oig.dot.gov

(800) 424-9071

OUR MISSION

OIG enhances DOT's programs and operations by conducting objective investigations and audits on behalf of the American public.



1200 New Jersey Ave SE
Washington, DC 20590
www.oig.dot.gov