Issue Brief

Governing AI with Existing Authorities

A Case Study in Commercial Aviation

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July 2024

Executive Summary

Recent advances in generative artificial intelligence have captured public attention and spurred a litany of proposals for regulating this transformative technology. A core question in these discussions is how U.S. government agencies can use their existing authorities to govern AI.

Virtually all of the sectors in which AI may be deployed are already regulated by one or more federal agencies. We argue that relying on existing agency authorities to govern AI in these sectors is the most effective strategy for promoting the safe development and deployment of the technology, at least in the near term. This approach will allow policymakers to respond more quickly to emerging risks and developments in the field, and it would also leverage the sector-specific expertise that already exists across the federal government.

In this report, we outline a process that could help policymakers, regulators, and researchers, as well as other interested parties outside of the government, identify existing legal authorities that could apply to AI and highlight areas where additional legislative or regulatory action may be needed. We believe this framework is applicable in many, if not most, sectors where AI is likely to be deployed. For the purposes of this report, we focus on how existing authorities can be applied in the commercial aviation sector, and specifically in relation to AI applications in aircraft onboard systems and air traffic control. We focus on commercial aviation because the sector has already made substantial use of automation, and there is a rich literature on the potential issues that could arise from the introduction of AI and other technologies that enable greater use of autonomous systems.

Today, the commercial aviation sector is primarily regulated by the Federal Aviation Administration. In general, we found that the FAA's existing authorities empower the agency to govern the development and deployment of AI systems in both air traffic control and aircraft onboard systems. However, we also identified gaps in the agency's existing regulatory regime that will need to be addressed in order to mitigate the unique risks presented by AI. Updating protocols and processes related to software assurance, testing and evaluation, personnel training, pilot licensing, cybersecurity, as

well as data management will help promote the safe use of AI across the commercial aviation sector.

Our case study of the FAA also spotlighted two common challenges that could hinder efforts to promote AI safety across the federal government:

1. **Talent**: acquiring the in-house expertise to develop and implement effective AI governance frameworks.
2. **Testing and Evaluation (T&E)**: developing standards and benchmarks that would enable stakeholders to accurately assess the safety of AI systems in various contexts.

Without these two enabling factors—talent and T&E—federal agencies will not be well-positioned to design and implement effective AI governance strategies. The Biden administration's October 2023 Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence (EO 14110) includes provisions aimed at addressing both the government's AI talent gap and the lack of common T&E standards for AI. However, the effect of these measures remains to be seen. Looking ahead, the successful implementation of a comprehensive AI governance strategy will depend in large part on understanding where agencies already have the legal powers necessary to oversee AI and where new authorities, regulations, and processes may be needed.

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Introduction

Recent advances in generative artificial intelligence (AI) have captured the public's attention and sparked a widespread debate about how the government should regulate this powerful technology. A variety of policy proposals have emerged from this discourse.

Some of these proposals focus on centralizing responsibilities for AI oversight within a new federal agency.[1] In September 2023, for instance, Senators Richard Blumenthal and Josh Hawley unveiled a framework that calls for standing up an independent body to implement a licensing regime for companies building "high-risk" or "sophisticated general purpose AI models."[2] This new "AI agency" could also be tasked with monitoring developments across the AI sector or reviewing information that private developers are required to submit to the government under the Biden administration's October 2023 AI executive order.[3] Proponents of this approach argue that the general-purpose nature of AI requires a body with broader remit, and a single organization would be better equipped to adjust regulations as the technology evolves.[4]

Others have pushed to delegate the responsibility for AI governance to existing federal regulators. This sector-based strategy is rooted in the idea that AI is a multipurpose tool, so rather than regulating it as a single technology, policymakers should instead focus on how AI tools are being used in different industries.[5] Federal agencies already have the authority to regulate virtually all major sectors of the economy, and those authorities generally extend to whatever technologies are involved in those operations, AI or otherwise. Proponents of this approach argue that relying on existing agencies and authorities would allow policymakers to act more quickly than if they tried to pass legislation and stand up a new governing body. Additionally, this approach would allow the government to leverage the sector-specific expertise already residing within relevant federal departments and agencies.[6]

These two approaches to AI governance are not mutually exclusive—most of the major frameworks released over the last year rely on some combination of centralization and delegation.[7] As policymakers build out a comprehensive strategy for AI governance, it will be crucial that they understand where agencies already have the legal powers necessary to oversee AI and where new authorities, regulations, and processes may be needed.[8]

The Trump administration previously sought to answer this question in 2019 when it released the Executive Order on Maintaining American Leadership in Artificial Intelligence (EO 13859), which asked federal regulators to review their authorities relevant to AI applications in the private sector.[9] The U.S. Department of Health and Human Services was one of the few to respond to this guidance. In its review, HHS found that a wide range of statutes related to civil rights, education, safe industry practices, and other topics could be used to regulate the development and use of AI, even though the statutes did not specifically mention the technology itself.[10] Such reviews would help other agencies understand where AI applications may or may not fall under their current jurisdiction. Today, however, there is no single, unified resource or systematic process that can help researchers or other interested parties outside of the government better understand the existing landscape of regulations across the varied sectors where AI is being applied, or could be used, in the near future.

Our team set out to develop a process that could help policymakers, regulators, researchers, and other interested stakeholders begin identifying authorities that could be applied to AI, as well as highlight areas where additional powers may be needed. While this process is by no means comprehensive, it provides a useful starting point for understanding how AI tools may be deployed in specific sectors; the particular risks and benefits those tools present; the regulators with potential jurisdiction over those tools; the authorities they can use to govern their development and use; and the authorities, regulations, and processes that may need to be introduced or updated to accommodate the unique challenges of AI.

By focusing on existing agencies and authorities, this framework inherently espouses a sector-based approach to AI governance. We recognize that some machine-learning applications—such as certain generative AI chatbots—may not fall neatly under the jurisdiction of any particular agency, and our approach does not preclude the creation of new authorities to govern these more general-purpose applications. That said, the sector-based approach to AI governance which undergirds this paper's focus on specific agencies and their respective regulatory powers offers several advantages, at least in the near term.

First, AI is evolving rapidly, and companies across the economy are already augmenting their operations with AI systems. If policymakers want to promote the safe development and deployment of these tools, they should act quickly. The federal government will be able to shape and affect the adoption and use of this technology across industries much faster using its existing authorities than if it waits to stand up a new “AI agency,” which will likely take years to fully fund and staff and even longer to gain its footing in the Washington bureaucracy.

Second, regulating these AI applications effectively requires an in-depth understanding of the industries, networks, and systems in which they are deployed. Leaning on existing agencies allows policymakers to capitalize on the sector-specific expertise that already exists within the government. Of course, many of these experts will likely need to become better acquainted with the specifics of AI in order to effectively regulate its applications within their industry.[11] This upskilling process will require time and resources. However, it will likely be more efficient to teach industry experts the features of a particular technology rather than teach experts in a particular technology the nuances of the numerous industries in which that technology will be deployed, especially considering the challenges of bringing technical talent into the federal government.[12]

As AI governance strategies are being implemented across federal departments and agencies, understanding agencies’ existing legal powers can help policymakers identify gaps in the current regulatory regime and make better informed decisions regarding the creation of new laws, policies, or governing bodies in the future. Finally, researchers, government watchdogs, and other interested parties outside of the government have a vested interest in understanding agencies’ existing legal powers in order to ensure that efforts to regulate AI are comprehensive and effective, and not undermined by waste, abuses of power, or mismanagement.

Mapping AI Authorities

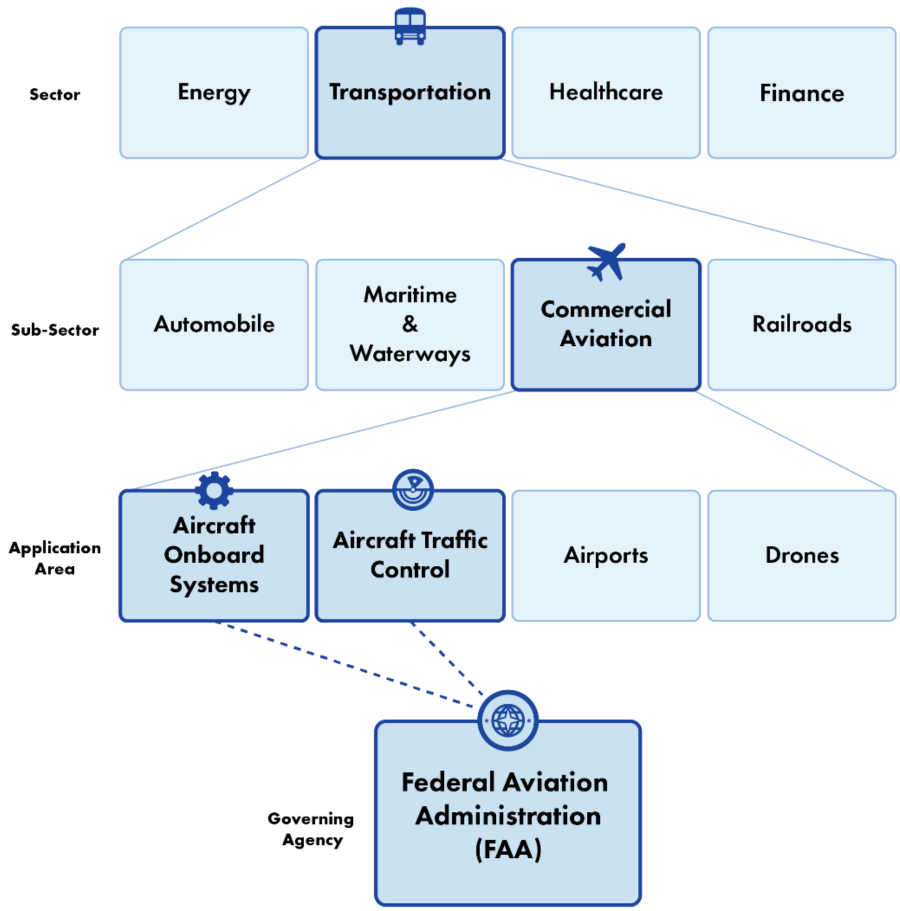
We approached this authorities mapping process from the perspective of an informed but non-expert stakeholder (e.g., federal policymaker, regulator, policy researcher, etc.), someone who is curious about how to approach regulating AI and has a high-level but non-expert understanding of the technical aspects of the technology's development and deployment.

Virtually every sector of the economy will be impacted by AI, and the nature of those impacts will in large part depend on the specifics of the sector. As such, we identified a number of industries where AI is likely to be incorporated, and selected one such sector—transportation—for closer examination (see Figure 1). We then identified a number of subdomains within the transportation sector in which AI has potential applications. We chose to focus on aviation because the sector has already made substantial use of automation, and there is a rich literature on the potential issues that could arise from the introduction of AI and other technologies that enable greater degrees of autonomy.

There are numerous potential use cases for AI tools across the commercial aviation sector, with more expected to emerge as the technology evolves in the years ahead.[13] For the purposes of this report, we specifically chose to focus on two areas within the field where AI has been or may soon be incorporated: air traffic control and aircraft onboard systems. In both use cases, the potential promise (safer air travel) and perils (deadly crashes) of machine automation, autonomy, and intelligence are tangible and highly consequential, and there is precedent and a desire for federal regulation.

After identifying AI use cases where potential regulations may be desirable, we mirrored the exercise for federal agencies. First, we identified the federal agency with clear jurisdiction over the transportation sector—the U.S. Department of Transportation—and the specific agency subcomponent responsible for overseeing the commercial aviation sector—the Federal Aviation Administration. We then analyzed the FAA's organizational structure to identify the offices responsible for managing our two selected AI application areas and the authorities upon which their oversight is based. Finally, we examined the ways existing regulations, policies, and processes intersect with current and future applications of AI. Our findings are detailed in the following section.

Figure 1. AI Authorities Mapping Process



Source: CSET.

While we began by identifying potential application areas for AI and proceeded to map those application areas to federal agencies, the process can also be conducted in reverse. For example, if an advisor to the Secretary of Transportation wished to understand how the agency could begin approaching AI governance, they could start by looking at the agency's subcomponents, their respective areas of jurisdiction, the AI use cases within each of those domains, the authorities that different components have at their disposal, and how those powers may or may not apply to AI.

AI in Commercial Aviation

The analysis below is not meant to be an exhaustive account of potential applications of AI in commercial aviation or existing FAA authorities to regulate AI tools used in air traffic control and aircraft onboard systems. It is likely our assessment is missing relevant authorities and other legal or regulatory tools familiar to domain experts. However limited, this initial effort illustrates how mapping the current regulatory landscape in key sectors can help scope out where AI is most poised to demand regulatory attention and where associated support will be needed.

Use Case 1: Air Traffic Control

According to the FAA, at any given moment there are roughly 5,400 aircraft flying within the 29 million square miles of airspace that falls under U.S. jurisdiction. The organization employs over 14,000 air traffic controllers to manage more than 45,000 average daily flights in the United States.[14] Air traffic control (ATC) is distributed across a variety of operational components. Air Traffic Control System Command Center (ATCSCC) coordinates flights at a national level, Air Route Traffic Control Centers manage high-altitude flight traffic, and Terminal Radar Approach Facilities (TRACONs) guide pilots entering or leaving the immediate area of airports, and at airport towers.[15]

Air traffic control entails a complex web of interactions among pilots, air traffic controllers, and technology systems. According to FAA regulations, although "the pilot in command of an aircraft is directly responsible for and is the final authority as to the operation of that aircraft," pilots and air traffic controllers have authority and responsibility at different times during a flight.[16] In addition, the FAA builds overlapping responsibilities among pilots and air traffic controllers into its regulations to ensure redundancy in case of failure or emergency.

Air traffic controllers manage the air space and the ground movement of airplanes at, around, and en route between airports. Their main responsibilities are to prevent aircraft collisions and manage traffic. They ensure planes reach their destination safely and efficiently, and monitor traffic, weather, and other conditions that could affect aircraft operations. Air traffic controllers communicate through one-to-one interactions with pilots, though controllers generally manage communications with multiple pilots at once.

Computers and automation have played a role in air traffic control since the 1960s and 1970s.[17] Computers initially integrated data from ground-based radars and airborne radar beacons, integrating data and identifiers to help controllers direct traffic and identify current and near-future aircraft traffic situations.[18] Beginning in the late 1990s, the FAA undertook efforts to modernize 1970s-era automation technologies by acquiring the Standard Automation Terminal Replacement System (STARS) for integrating ATC data, implemented and sustained through the Terminal Automation Modernization and Replacement (TAMR).[19] As part of the FAA's broader Next Generation Air Transportation System (NextGen) initiative, by 2015, the FAA also adopted En Route Automation Modernization (ERAM) as part of a transition from ground to satellite-based air traffic management, reportedly allowing for an increased ability to track aircraft and improved, customizable user displays and tracking accuracy.[20] The agency has begun to incorporate a range of other technologies to assist with integrating flight data from multiple sources for controllers.[21] For example, in some circumstances and with prior approval, controllers and pilots can also share data links to communicate beyond potentially unclear verbal exchanges. This comes into play when delivering and accepting ATC approval to land (though using a data link is not required).[22] As of 2018, however, the U.S. Department of Transportation's Office of the Inspector General found that the FAA was struggling to integrate STARS and other NextGen capabilities, and efforts to integrate, sustain, and enhance the system are ongoing.[23]

AI Applications in Air Traffic Control

ATC is currently facing a range of challenges where AI applications and technologies could provide solutions that increase safety and efficiency. The growth of the airline industry, high quantity of air traffic, staffing shortages, and the overall growing complexity of ATC operations have strained air traffic controllers and systems, possibly contributing to recent near-miss runway incidents.[24] Radio frequencies used by pilots and air traffic controllers to communicate can become congested when traffic is high or the weather is poor, leaving pilots awaiting responses from controllers juggling multiple priorities. Communication is also undermined by “unclear semantic expressions by controllers, slips of the tongue, or the issuance of unreasonable ATC instructions" which can create unsafe incidents.[25] Indeed, studies based on flight accident reports suggest that as many as 70% of aviation accidents were due to human factors like communication, cooperation, and decision-making.[26]

AI could serve various purposes in ATC, ranging from decision support for air traffic controllers to assisting with real-time traffic management, maintenance, modeling, and training, as well as risk and accident analysis.[27] For example, using AI, air traffic controllers could theoretically plan to direct flight traffic more quickly and efficiently. Systems could provide recommendations on optimal flight paths and create demand forecasts for specific sections of airspace, allowing controllers to plan for especially busy traffic. AI could also facilitate splitting airspace into the ideal sectors for controllers to manage—so-called optimal sectorization—based on data inputs related to traffic, terrain, and weather conditions.[28]

In 2023, the FAA commissioned a study on how AI could be used in collision risk models, particularly to create models that can simulate rarer or more complex aircraft navigation events.[29] AI models could generate sufficiently large amounts of synthetic flight data for analysts to observe the likelihood of potential collision events that might not occur frequently enough to be captured in real-world scenarios or less sophisticated simulations. The study also pointed out that natural language processing could scan operational logs and audit incident reports and other documents to estimate measures of certain keywords and determine the likelihood of a risk event given certain data indicators.[30] Most recently, the FAA’s FY 2024-2028 *National Aviation Research Plan (NARP)* also identified weather hazard mitigation and simulations for system safety management and terminal area safety as priority research areas for AI.[31]

Some uses of AI also fall outside of actual ATC operations, but could nonetheless prove useful for analysis and safety. For example, automatic speech recognition techniques could be used to convert ATC speech patterns into text, generating reports that could be processed and read for post-operations analysis, real-time operations safety monitoring, or air traffic control training.[32] AI classifiers could also categorize and search different safety reports or incident databases, such as NASA's Aviation Safety Reporting System, thereby allowing analysts to detect air safety trends from among massive amounts of textual reporting that would otherwise be difficult for a human to achieve.[33]

While the integration of AI into ATC could have a number of positive aspects, it may also create certain risks. Reliability issues around AI systems' performance could make integrating the technology into existing systems and processes difficult, particularly since AI models are presently hard to test, evaluate, and certify. As in other sectors beyond commercial flight, certifying AI performance remains a challenge, and models can perform poorly or be prone to accidents in real-life settings that differ from their training conditions. Their outputs can be opaque and hard to interpret, and testing, evaluation, verification, and validation (TEVV) practices for AI systems remain an area of active research. Aside from purely technical challenges, malicious actors could pose different threats to the data resources, cybersecurity, or other aspects of AI systems. Managing and protecting data resources for AI-enabled systems and maintaining the security of AI algorithms and systems themselves will be paramount.

As mentioned, operational complexity and heavy mental workload is already a problem for air traffic controllers. Initially, the introduction of AI could increase the cognitive burden on controllers integrating new systems and processes into their decision-making and workloads. While these challenges could likely be overcome with additional resources, training, and thoughtful design of systems to facilitate human-computer interactions, the introduction of AI systems could create new complexity for ATC workers in the short term.

Another challenge is the difficulty of automating the ATC decision-making process given the high number of decision inputs involved, as well as the variety of actions that can be taken in different sequences to solve a given problem.[34] Automation bias, or the risk that humans default to decisions provided by AI-enabled or automated systems, poses another challenge in the ATC context and beyond. New training for the use of AI-enabled systems will likely need to emphasize the systems' limitations to human users, particularly as they pertain to decision support, and illustrate the risks of automation bias and other human factors in AI deployment.[35]

Existing Authorities and Potential Gaps

In the United States, the FAA maintains responsibility for "developing and operating a common system of air traffic control and navigation."[36] We examined a number of these authorities from the U.S. Code, where they are described at length, particularly in 49 U.S.C. § 445 and § 447.[37] Specifically, the FAA sets rules and procedures for air traffic controllers, protocols governing interactions between air controllers and pilots, managing runway traffic, providing flight clearance, and providing guidance across a range of scenarios, among others.[38]

A number of the authorities held by the FAA are likely already applicable to the incorporation of AI into ATC processes and procedures. For example, the Administrator of the FAA can "develop, alter, test, and evaluate systems, procedures, facilities, and devices, and define their performance characteristics, to meet the needs for safe and efficient navigation and traffic control of civil and military aviation," and "select systems, procedures, facilities, and devices that will best serve those needs and promote maximum coordination of air traffic control and air defense systems."[39] Subsection §44505 also describes how the FAA may research the development and maintenance of safe technology systems and certify their performance.[40] In addition, subsection §44506 relating to practices around air traffic controllers allows for the development of training methodologies, research into "human perceptual capabilities and the effect of computer-aided decision-making on the workload and performance of air traffic controllers" and "air traffic controller workload and performance measures, including the development of predictive models."[41]

There are some mentions of procedural preferences in FAA Order JO 7110.65Z, Air Traffic Control, dated June 17, 2021, that may be relevant to AI.[42] These pertain to the use of automated technologies and procedures, and state that air traffic controllers should "use automation procedures in preference to nonautomation procedures when workload, communications, and equipment capabilities permit." Preference is generally given to using automated systems to help ease operator workloads and determine optimal flight plans where appropriate. In addition, in August 2022, the FAA shared a research plan focused on the certification of new and emerging technologies, particularly AI-based technologies, highlighting that current software assurance practices as well as the FAA's TEVV processes will likely need to be expanded to better fit the unique challenges and requirements of AI systems.[43]

There appear to be few or no specific regulations or laws that pertain directly to AI and aviation.[44] However, it is easy to see how the broadly defined nature of existing authorities could be applicable to the development, acquisition, testing, evaluation, and implementation of AI systems in air traffic control. Consideration for system development and design and the human factors involved in capitalizing on new technologies in ATC fall within the FAA's remit, and are written so as not to be limited to a new given technology. Current authorities, with the possible addition of amendments or specific pilot projects where appropriate, appear to be equipped to provide a basis for governing AI in the use of ATC.

That said, there could be gaps in the way that the FAA goes about enforcing regulations and governance of AI in ATC, including in self-regulation, budget constraints, and the agency's reliance on external expertise to develop and approve technologies involved in ATC. The FAA has drawn criticism for its role as both the executing agency and regulator of ATC, which some experts have noted may constitute a potential conflict of interest around safety monitoring.[45] For instance, the FAA is typically involved in the development and operation of ground systems, radars, and computers, which it then certifies are safe for the national airspace system after testing and evaluation. In contrast, the FAA only certifies (i.e., is not involved in the design of) aircraft equipment components, which it ensures align with Federal Aviation Regulations. Systems with both ground and air components must undergo both processes, and the FAA can enforce new standards for incorporating new technology into aircraft components among airlines.[46] Navigating this dual developer-certifier approach could prove challenging with AI systems integrating the data and outputs of many different systems, and may require new software assurance models.

The FAA has also attracted scrutiny over regulatory capture given that it often maintains close relationships with the firms it is tasked with regulating and in some situations allowing self-certification.[47] These criticisms reflect fundamental realities of the FAA's structure, budgetary concerns, and dependence on external expertise which will likely also shape the agency's ability to regulate the incorporation of AI into ATC systems and processes.

In addition, the FAA will need to determine how and whether the opacity of certain AI systems will affect a technology-first approach to ATC, a concern that does not appear to be clearly addressed in current regulations. Since air traffic controllers are already familiar working with highly automated systems, it will be important to understand how AI-enabled systems differ from existing decision support ATC systems, particularly in terms of transparency and explainability, and the relative risks of accidents or malfunctions of these new technologies. Given the high workloads of air traffic controllers and the traffic and time pressure inherent in the work, studies indicate that the potential for automation bias is already concerning, even before incorporating AI into ATC processes.[48] Addressing these gaps and others will likely be key to any future AI-ATC governance efforts.

Use Case 2: Onboard Systems

Modern aircraft are astonishingly complex machines consisting of numerous mechanical, electrical, and digital systems. By controlling and managing the interactions between these various systems—engine, fuel, hydraulics, propulsion, environmental control, etc.—pilots are able to safely and efficiently transport passengers and cargo.

Since nearly the dawn of aviation, an increasing number of onboard functions have become automated. The first autopilot system was introduced in 1912, and over time pilots have handed over more of the fundamental functions of flying to the aircraft itself.[49] Today, pilots spend much of their time monitoring the operations of automated systems and typically only step in to manually fly planes for brief phases of the flight.

While this trend toward automation has made aircraft safer overall, it has also made the process of piloting a plane more complex, particularly when something goes wrong and the automated system takes action to address the problem. This intervention frequently occurs without the pilot's input, and it can take time for pilots to recognize that automated systems have kicked in. As such, instead of responding directly to their environment, pilots now must understand how the aircraft itself is interpreting and responding to the environment before identifying the best course of action. In short, automation leads to fewer problems overall, but it can make problems harder to diagnose and correct when they do occur. A 2021 *Wired* op-ed quoted Captain Chesley Sullenberger as saying, "it requires much more training and experience, not less, to fly highly automated planes."[50]

Some believe integrating AI into these onboard systems will improve the safety and efficiency of commercial aircraft.[51] But despite its purported benefits, AI could also have the unintended effect of making an already complicated "network of networks" even more complex and opaque, potentially creating confusion in the cockpit and leading to dangerous situations.

AI Applications in Aircraft Onboard Systems

The onboard system with the most potential for AI integration is likely the flight management system (FMS), which governs navigation, performance, and in-flight operations from takeoff to landing.[52] The FMS is composed of multiple interconnected components that receive and process information on flight plans, onboard sensor data, and geolocation, and adjust aircraft functions accordingly. The FMS promotes efficiency and prevents the aircraft from entering "unsafe states."

While highly automated, today's onboard flight systems largely do not rely on machine-learning algorithms.[53] The FMS operates in accordance with predefined aerodynamic models, and when situations arise that fall outside the constraints of these models, the pilot is required to intervene. Integrating AI into onboard systems could potentially expand the "window" of predefined conditions in which an aircraft can operate autonomously, reducing the number of unexpected situations that necessitate pilot intervention.

Aircraft manufacturers have already started experimenting with AI to enhance landing, taxiing, and in-flight capabilities.[54] Airbus recently tested an autonomous emergency diversion capability, which would allow the plane to safely land itself if pilots become incapacitated.[55] The company is also testing AI applications that would allow for a single pilot, rather than two, to operate commercial aircraft.[56] Meanwhile, Boeing is testing AI to analyze FMS data to help pilots diagnose and correct problems that arise mid-flight.[57] Boeing's Phantom Works division is also working to develop autonomous combat aircraft—any resulting breakthroughs could have applications in commercial aviation.[58] While autonomous flight is in many ways the holy grail of AI-enabled aviation, the technology could also be deployed to promote more efficient use of fuel, optimize flight paths, enable predictive maintenance, and other functions.[59]

However, introducing AI into onboard systems presents potential challenges. For one, models trained on incomplete or otherwise faulty datasets could put aircraft in unpredictable or hazardous situations, and today the FAA's software certification practices do not account for the quality of AI training data.[60] Another concern is that AI tools may muddle the mental models that pilots use to understand how different onboard systems interact and how malfunctions in one part of the system affects the behavior of others.[61] Today's AI models are often characterized as "black boxes," making decisions that can sometimes be difficult for humans to explain or interpret. For example, an AI system deployed onboard a commercial aircraft may respond differently in two situations that look identical to the pilot but differ in a way that is noticeable only to the AI. While this ability to recognize imperceptible patterns can improve the safety and efficiency of commercial aviation, it can also potentially lead to confusion in the cockpit, particularly in abnormal flying conditions or cases of system malfunctions. If onboard AI systems cannot explain why they made certain decisions, pilots will struggle to interpret how the systems are functioning within the aircraft and make informed, timely decisions that ensure the safety of those on board and on the ground.

Human-Machine Teaming in Commercial Aircraft: How pilots and airplanes work in tandem is ingrained in systems through protocol and operational requirements, and in the wider institutional policies and standards that oversee human-machine collaboration, teaming, and integration. For instance, Airbus and Boeing have unique perspectives regarding automation and human-machine teaming on their flight decks. Airbus focuses on "hard" limits, permitting the automated system to make most decisions except when safety is at stake, whereas Boeing opts for a "soft" limit approach that assigns the pilot as the ultimate authority.[62] Changes to some onboard flight management systems that conflicted with the existing philosophy of soft limits on the 737 Max Boeing airplanes (which made it more difficult for pilots to manually override the system) played a direct role in two fatal accidents: one in 2018 and the other in 2019.[63] The investigations into these crashes found that the human element was inadequately addressed in the integration of the new system, which was launched without providing adequate notice, training, and guidance to pilots regarding their roles and procedures in overriding and managing the updated version of the system.

Existing Authorities and Potential Gaps

The FAA has at its disposal a variety of authorities that enable the agency to "promote safe flight of civil aircraft in air commerce." These authorities are described at length in 49 U.S.C. § 447.[64]

When it comes to governing AI in aircraft onboard systems, the FAA has two relevant legal powers. First, there is the authority to certify commercial aircraft (49 U.S.C. § 44702, 44704, 44709, 44711-44713, 44715-44717, 44725). Today, this certification function is carried out by the agency's Aircraft Certification Service (AIR). The AIR is responsible for developing safety standards and regulations for aircraft, approving the design and production of aircraft and their components, and certifying the airworthiness of completed aircraft.[65] Without this certification, aircraft are not legally authorized to fly. Given that the AIR is equipped to regulate the design and use of all technologies integrated into commercial aircraft, it necessarily has jurisdiction over onboard AI systems.

Second, the FAA has the authority to approve pilot training programs and license commercial pilots (49 U.S.C. § 44703, 44707, 44709-44711, 44726, 44729), and it can use this power to ensure that pilots are prepared to fly aircraft equipped with AI systems.[66] The agency publishes guidance on pilot training requirements, which dictate that pilot candidates show they can function effectively in various environments such as adverse weather conditions and at high altitudes.[67] Moreover, there are instrument proficiency check requirements mandating that pilots demonstrate that they can competently operate the airplane.[68] FAA guidance stipulates that training providers are authorized to make updates to their training programs based on new technological developments, which would include the integration of AI into onboard systems. Beyond generally licensing pilots, the FAA also has the authority to approve aircraft-specific pilot training programs that manufacturers are required to develop for new aircraft.[69] These training programs ensure that pilots are familiar with the various systems aboard each aircraft and equipped to safely operate the aircraft in normal as well as emergency situations.

Based on our initial assessment, it does not appear that the FAA will require any additional authorities to govern AI in aircraft onboard systems. Through its existing aircraft certification and pilot licensing authorities, the agency can regulate the safe development and deployment of new AI tools and ensure that pilots are trained to safely handle aircraft equipped with this technology.

However, the fact that the FAA is able to govern AI with its existing authorities does not mean its current regulatory scheme is up to the task. Our review found that the FAA will likely need to update specific regulations, protocols, and processes to promote the safe and responsible use of AI in the commercial aviation sector. For instance, the agency should consider revising its software assurance processes to accommodate the unique features of AI systems. Today, these processes are based on "repeatable and deterministic results," "complete traceability of system requirements," and "repeatable, comprehensive testing of typical input ranges," all of which are difficult to apply to AI.[70] The FAA and NASA are currently working to update their software assurance process to handle AI in the air traffic control ecosystem, and their findings could likely be applied to commercial aircraft certification. Similarly, the International Civil Aviation Organization (ICAO), a United Nations agency that regulates international airspace, has undertaken a variety of AI governance efforts, which could help inform the FAA.[71]

Other criteria, such as those intended to minimize flight crew errors and confusion related to the flight guidance system, may also need to be updated if AI is introduced into these systems. This may involve regulating how and where AI tools can be used within different onboard systems, and developing performance standards that those tools must meet.

Additionally, the agency should ensure its pilot training requirements leave pilots properly equipped to operate aircraft that contain AI systems. This instruction may be incorporated into airline transport pilot certification training programs.[72] Additional training on AI systems should also be incorporated into required crew resource management training provided by airlines, as well as aircraft-specific training modules, which are developed by manufacturers and approved by the FAA.[73] Pilots are already familiar with highly automated systems, but it will be important that they understand the specific challenges (e.g., lack of repeatability) that AI systems present and how that may impact the operation of the aircraft. As with ATC, the potential for automation bias—defaulting to decisions provided by AI-enabled or automated systems—could be high, and addressing these issues will be critical to future pilot training requirements.[74]

General AI Governance Challenges

In both case studies, we identified a set of overarching challenges that policymakers are likely to face as they work to design and implement AI governance initiatives. These challenges will apply not only in commercial aviation, but across the wide range of industries and sectors in which AI systems either already are or will soon be deployed. While specific obstacles may vary depending on context and application, regulators across government will face two major shared challenges as they grapple with AI: 1) acquiring in-house technical talent and 2) developing testing and evaluation (T&E) standards. We view both talent and T&E as "enabling factors" that will undergird virtually all responsible and safe AI governance initiatives across the federal government.

Talent

In its 2021 final report, the National Security Commission on Artificial Intelligence argued that the AI talent deficit will be the single biggest impediment to the US government being "AI-ready" by 2025.[75] Acquiring this talent—workers with technical and non-technical expertise in both AI and its role in different economic sectors—will be crucial for the government's efforts to develop and implement effective AI governance strategies. The Biden administration recognized this fact in its AI October 2023 executive order, which called on policymakers to update a variety of hiring processes and policies to instigate "a national surge [of] AI talent" into the federal government.[76]

In the case of commercial aviation, for example, our two case studies showed the FAA will need to update specific technical processes to address the unique challenges posed by AI. Revamping these procedures will require regulators to have both an understanding of general AI systems as well as the specific technical environments in which they are being used (e.g., air traffic control). However, it does not appear that the FAA currently employs the experts it will need to develop and implement these changes.[77]

When confronted with such workforce gaps in the past, the FAA has outsourced certain responsibilities—such as aircraft certification tasks—to third parties.[78] While this practice is authorized by law, outsourcing governance can create its own risks. For years, watchdog groups have warned that the FAA does not properly supervise its third-party certifiers, and these lapses in oversight have been implicated in recent safety incidents involving Boeing aircraft.[79] While outsourcing certain AI governance tasks may have some benefits for safety and efficiency, the FAA and other regulatory agencies will nonetheless need a robust pool of in-house AI experts to ensure such programs are implemented effectively.

Testing and Evaluation

The FAA and other federal agencies will also face common challenges related to testing and evaluating AI systems. While AI systems will pose different risks in different application areas, they present a common set of issues, such as algorithmic bias and a lack of explainability and transparency. Across application areas, software assurance practices will need to be structured to accommodate the unique challenges posed by AI systems—linear, sequential, and static assurance processes will not work for a technology that is continuously learning and adapting. Given how rapidly AI systems are evolving, software assurance and testing may need to adapt over time. Setting safety thresholds for different AI systems will require a standardized approach to testing and evaluating various models, but today these standards do not exist. Establishing common standards for AI safety is a known challenge and will likely require specialized processes and expertise. However, creating these procedures for AI is particularly complex, given that it is a broad, enabling, general-purpose technology that is not necessarily immediately interpretable to humans.[80] In its AI executive order, the Biden administration charged the National Institute of Standards and Technology with creating guidance and best practices for developing AI safety standards, and NIST recently established an AI Safety Institute to manage this process.[81]

In the context of commercial aviation, the FAA will be responsible for setting some standardized baseline requirements for AI applications and ensuring those requirements are met. Already the FAA has recognized this, and has, in a joint effort with NASA, worked to develop an AI Certification Framework.[82] However, this effort has proceeded slowly and risks duplicating work done elsewhere within the federal government.[83] While the FAA's joint effort with NASA states it "will engage with industry and international standards bodies to stay informed of related efforts," this may prove challenging given how quickly the technology is progressing. Moreover, efforts to implement standard testing requirements are further compounded by the previously discussed lack of sufficient in-house capacity and talent.[84]

Conclusion

Amid rapid progress in the field of AI, policymakers are grappling with how best to govern this transformative technology. A variety of policy proposals have emerged over the past year, several of which involve creating new regulations, authorities, and oversight bodies to govern AI systems. While updated or wholly new policies and regulations may indeed be necessary, we argue that the most effective strategy for promoting the safe and responsible development and deployment of AI—at least in the near term—is to empower agencies to use their existing authorities. This approach will allow policymakers to respond more quickly to emerging risks and developments in the field, and it would also leverage the sector-specific expertise that already exists across the federal government.

In this report, we outlined a process that is intended to help policymakers, regulators, and researchers or other interested parties outside of the government identify existing legal authorities that could apply to AI and highlight areas where additional legislative or regulatory action may be needed. We demonstrated how this exercise could be used in relation to the commercial aviation sector and found that the FAA already has the authorities necessary to govern AI tools deployed onboard commercial aircraft and across the air traffic control ecosystem. Other federal regulators will likely find themselves in a similar position given that many of their existing governance authorities are technology-agnostic. A small number of agencies, including HHS, have already undertaken parts of this process, and we encourage others to follow their lead.[85]

In certain cases, however, agencies will need to augment existing processes and procedures to address safety challenges specific to AI. In the case of the FAA, for example, the agency will likely need to update its software assurance process, pilot training procedures, and air-traffic controller training as it pertains to the incorporation of AI into ATC infrastructure and aircraft onboard systems. The specific risks presented by AI will vary across sectors, and federal regulators will need to tailor their governance frameworks accordingly. However, we identified two common challenges that could hinder AI safety efforts across the federal government: 1) acquiring the in-house AI talent to develop and implement effective governance frameworks; and 2) developing testing and evaluation standards that would enable stakeholders to accurately assess the reliability, robustness, safety, and security of AI systems in various contexts. Without these two enabling factors—talent and T&E—federal agencies will not be well-positioned to design and implement effective AI governance strategies. The Biden administration's October 2023 AI executive order includes provisions aimed at addressing the government's AI talent gap, as well as the lack of common T&E standards for AI. However, the effect of these measures remains to be seen.

To be sure, policymakers will likely face other challenges as well. For instance, managing the intersection between AI systems and their human users is a crucial component of AI governance. While some regulatory agencies like the FAA have experience overseeing complex human-machine interactions, others will need to significantly adapt their regulatory frameworks to address these issues. Additionally, agencies will struggle to effectively adopt and govern AI tools if they do not first accomplish more fundamental IT modernization efforts. For example, AI systems deployed in air traffic control operations will suffer the same data accessibility challenges faced by human controllers unless the FAA updates its legacy hardware and software infrastructure.

The Biden administration's AI executive order represents a first step toward promoting responsible development and deployment of AI systems. However, the order's broader goals will require sustained commitment of resources, personnel and funds, as well as continuous monitoring of federal initiatives to ensure they are implemented effectively and actively advance the United States' broader national security and economic objectives.[86]

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Acknowledgements

The authors would like to thank Margarita Konaev for providing invaluable guidance and insights on this project during her tenure as CSET's deputy director of analysis. For feedback and assistance, the authors would like to thank Zach Arnold, Matthew Burtell, Adam Conner, Will Dobbs-Allsopp, Anthony Ferrara, Shelton Fitch, Heather Frase, Jessica Ji, Ngor Luong, Jason Ly, Igor Mikolic-Torreira, Jahnavi Mukul, Mina Narayanan, Helen Toner, and Thomas Woodside.

Document Identifier: doi: 10.51593/20230051

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[84] For example, given the FAA's limited expertise in the technology, the agency may not be equipped to determine if the certification process or testing and validation efforts that were delegated to aircraft manufacturers and other designated organizations were, in fact, conducted effectively. For instance, government watchdogs and the National Transport Safety Board found that shortcomings in the FAA's delegation and certification processes undermined its oversight of the Maneuvering Characteristics Augmentation System (MCAS) in the Boeing 737 Max, the flight control software that contributed to the aircraft's two fatal crashes in 2018 and 2019—in particular, the types of hazard testing and assessments of the system that were conducted. For more information, see: National Transportation Safety Board, *Assumptions Used in the Safety Assessment Process and the Effects of Multiple Alerts and Indications on Pilot Performance*, (Washington, D.C.; National Transportation Safety Board, 2019), https://www.ntsb.gov/investigations/accidentreports/reports/asr1901.pdf; "Certification Reform Efforts," *Federal Aviation Administration*, Accessed April 2024, https://www.faa.gov/aircraft/air_cert/airworthiness_certification/certification_reform; Office of the Inspector General, *DOT's Top Management Challenges* (Washington, D.C.; U.S. Department of Transportation, 2021), https://www.oig.dot.gov/sites/default/files/DOT%20FY%202022%20Top%20Management%20Challenges.pdf#page=8.

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