UK Civil Aviation Authority

CAA's Strategy for AI

AI in Aviation: A Technology Outlook
CAA Horizon Scanning and Insight

CAP3019
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The CAA's Strategy for AI

Introducing the CAA's Strategy for Artificial Intelligence (AI) . With a dual focus on enabling the deployment of AI within the aviation sector and utilising it as a regulatory tool, this initiative aims to elevate safety measures, enhance operational efficiency, and foster innovation.

The aviation industry continues to embrace the transformative power of AI. It already enhances safety and efficiency through predictive maintenance, aiding air traffic management, and refining pilot training with advanced insights and simulations. But the future of AI will usher in a new era in aviation.

But what does it mean for the CAA? How will it affect the way we work, and what we regulate? These are the questions the CAA's Innovation Hub hopes to tackle with a new CAA Strategy for AI, to be published in Summer 2024.

This document is part of the 3 tools to support the strategy.

- Tackling the terminology of AI is important to create common language so that we can have a level and transparent conversation with innovators. (CAP2966)

- Providing a set of principles that will help to steer how we regulate AI while enabling AI innovation to flourish. (CAP2970)

- Horizon scanning the future of AI, to keep us abreast of the technological developments (this document).

Artificial Intelligence and increasing degrees of autonomy have the potential to impact every part of the sector and across the CAA itself. These effects can be described in 3 broad categories for the CAA.

What we regulate

We are already seeing applications of AI in some of the proposals that reach our Innovation Advisory Services team in the CAA, and even within applications received by our regulatory approval teams.

How we regulate

The power of AI to rapidly process and analyse large volumes of data presents us with an opportunity we should not ignore. We are just scratching the surface of the potential to improve how we carry out our regulatory duties.

How we operate

As with any other organisation, the power that AI brings to help colleagues on a day-to-day basis is transformative. Whether it's helping to draft a new CAA publication, create a financial report, or produce meeting notes, AI tools will soon become a natural and essential part of our working lives.

The CAA's forthcoming strategy will explore the regulation of both AI and high degrees of autonomy.

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The potential benefits of creating intelligence are huge. We cannot predict what we might achieve, when our own minds are amplified by AI.

Stephen Hawking

The CAA's Horizon Scanning and Insight Function

As a part of the UK CAA's vision for a proactive approach to innovation in the aviation industry, the Horizon Scanning And Insight mechanism enables the exploration of AI technologies.

The aviation landscape is changing fast; new technologies, business models, and new market entrants are changing ways of working, and posing unknown risks and opportunities, which may change how the CAA works and regulates others. To continue providing cross-organisation regulatory standards, we must future-proof our services by keeping a lookout for new trends that could affect the CAA and aviation users. This is achieved by:

- Engaging proactively with the industry, academia, and government on emerging technologies.

- Participating in relevant working groups that are developing industry and government strategies for implementation of emerging technologies.

- Identifying and exploring innovation challenges for emerging technologies to uncover their complexities and safety performance levels and feeding this knowledge into the CAA's rule-making plan.

The CAA is responsible for ensuring the UK aviation industry meets the highest safety standards, protects consumers and the public, and maximises efficient use of airspace. Horizon Scanning supports our regulatory duties by assisting in identifying and exploring challenges from emerging technologies to inform our strategies for regulatory change.

To manage our duties as a world-leading regulator, we must look to the future. The HS&I function provides a technology review and timeline for key emerging themes in aviation. We proactively share these insights to the larger industry on where regulatory input will be required and where we should collaborate to ensure the highest level of safety assurance is met when applying these new technologies.

This paper explores the horizon for trends relating to artificial intelligence. It will provide insights to the CAA's development of our first Strategy for AI and help us to continually adapt that strategy in response.

Artificial Intelligence is Developing Exponentially
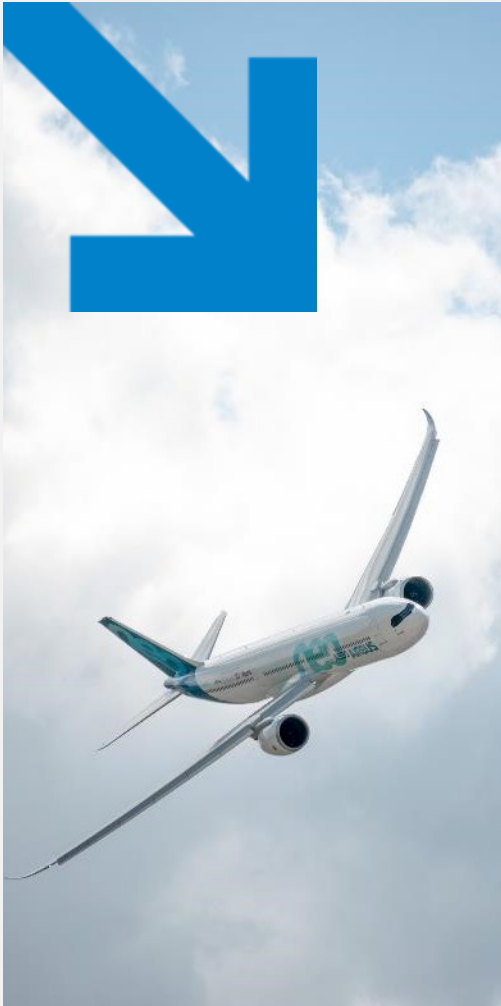
Continuous and rapid developments in the field of AI in recent years have pushed towards the adoption of this transformational technology across all sectors of the economy

This technological revolution is no accident. There are 3 main drivers behind recent developments:

Big Data. After decades of digital transformation, organizations now possess massive volumes of data from numerous sources. This "Big Data" is an asset for developing and training AI models, but poses challenges in storage, processing, analysis, and extracting meaningful insights. Harnessing Big Data is crucial for AI advancement, as it requires advanced tools, analytical techniques, and data science expertise to unlock the potential of large datasets and drive innovation in artificial intelligence applications.

Computational Power. Cloud computing, advanced computing hardware, such as Graphics Processing Units (GPUs) and Tensor Processing units (TPUs), and advanced networking technologies, such as 5G, enable organisations to generate, transmit, store and process data at extremely high velocities. This is enabling very advanced computations to be performed in reasonable timeframes and at a reasonable cost.

Algorithms. Hugely improved algorithms have been developed for an array of computational problems, particularly in the area of Machine Learning. Rather than being explicitly programmed, software is created by learning from data and training to perform tasks that otherwise would require human action. From Deep Neural Networks and Deep Learning, to Foundation Models and Large Language Models, humans' interaction with computers has evolved to a much more powerful level.

AI Applications in Aviation

AI adoption and responsible integration into the various facets of aviation promises to propel the industry into the future, delivering improvements for safety, security, efficiency and sustainability.

We have attempted to organise our understanding of emerging and potential future applications of AI in Aviation in three categories: Platform, Infrastructure, and Airspace applications.

However, aviation is a highly interconnected ecosystem and, understandably, some applications may cross these boundaries. Therefore, this classification is used purely for illustration purposes.

Both AI and Aviation are broad and fast evolving fields, and the intent of this report is to highlight some key **potential applications** rather than provide an exhaustive list of products for the individual fields.

Platform Applications

- AI-enabled flight control
- AI-enabled avionics
- Increased flight automation

Infrastructure Applications

- Streamlined airport operations
- Passenger journey optimisation
- Ground handling automation

Airspace Applications

- Air Traffic Control (ATC) automation
- Flight routes optimisation for safety and efficiency
- Airspace utilisation optimisation

Aircraft Platforms

Aircraft Control

Enabling increased autonomy for aircraft flight operations through real time data processing and AI-enabled adaptive decision-making.

Simulation Training Optimisation

AI systems allow realistic simulations of scenarios, providing more adaptive challenges to increase competency amongst flight crew through data-driven feedback.

AI and Autonomy of the Flight Deck

Exploration of single pilot operations for commercial fixed-wing are reliant on developing AI systems based on decision-making processes allowing pilots capabilities to be augmented towards more safety critical elements.
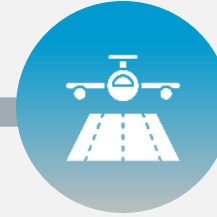
Unstable Approaches

Real-time monitoring of flight parameters within AI systems can assist in maintaining stability on landing with the aim of mitigating risks associated with unstable conditions.

AI could enable higher levels of autonomy for aircraft systems, including applications in conventional fixed wing and rotorcraft, as well as novel aircraft classifications, such as Remotely Piloted Aircraft Systems (RPAS) and Electric Vertical Take-off and Landing (eVTOLs) vehicles.

Development of technical standards will be key to enable AI to be deployed into aircraft and drive towards higher levels of flight autonomy.
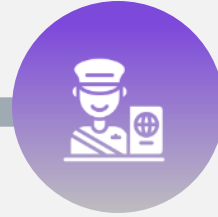
Aviation Infrastructure

Airport Passenger Services

Application for airport operations by enhancing efficiency in baggage handling and passenger flow.

Border Security

AI aims to strengthen biometrics for security through advanced surveillance, facial recognition, and anomaly detection to safeguard against potential threats.

Airport Ground Operations

AI could help optimise areas of ground operations such as aircraft maintenance, ground handling and autonomous taxiing (early trials of which aim to enhance sustainability).

AI development from recent discussions with airports and the wider industry indicate aviation use cases are targeting streamlined operations within airports.

Infrastructure applications of AI shows broad utilisation opportunities. For instance, airside and landside operations both provide opportunities for an increased level of autonomy as defined by CAP2966, "Speaking a Common Language".

Airspace

Air Traffic Management

Air Traffic Management systems look to integrate AI for real-time data analysis, predictive modelling, and decision support, improving overall airspace efficiency and safety.

Weather & Impact Prediction

Development in maturing algorithm frameworks for the purpose of identifying weather patterns. Predictions in weather can contribute to early identifications of turbulence and weather abnormalities.

Performance Based Navigation

Early applications for Air Traffic Control target better conflict management of airspace users. Conversations between aerodromes and regulator look to research system applications based on performance of individual airports.

Increased volumes of flights within the UK airspace, combined with the need for integration of new users, will likely lead to the demand for higher levels of automation within Air Navigation and Air Traffic Services to support safe, scalable and sustainable operations.

AI could help deliver the Airspace Modernisation Strategy vision for quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
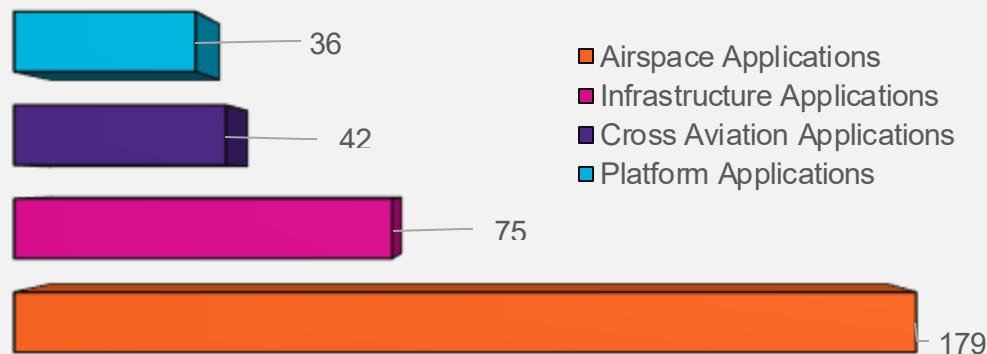
AI Patents and Themes

Reviewing registered patents for AI technologies is a valuable exercise for gaining insights into this rapidly evolving landscape. This analysis of patents not only provides a snapshot of the latest innovations, but also offers insight into the strategic direction of developers and researchers.

By examining the intellectual property surrounding AI, it's possible to identify emerging trends, potential market disruptors, and critical areas of focus. Additionally, discovering novel applications of AI will aid us in fostering a better understanding of how this transformative technology is reshaping many industries.

AI Global Patents Recorded in Aviation, 2023

- ■ Airspace Applications
- ■ Infrastructure Applications
- ■ Cross Aviation Applications
- ■ Platform Applications

- 36
- 42
- 75
- 179

Based on **statistical analysis** from a sample size taken via patents filed during the periods between January 2023-December 2023 from patent website lens.org, we were able to conclude the total AI patent applications for the **aviation system in general** across the globe.
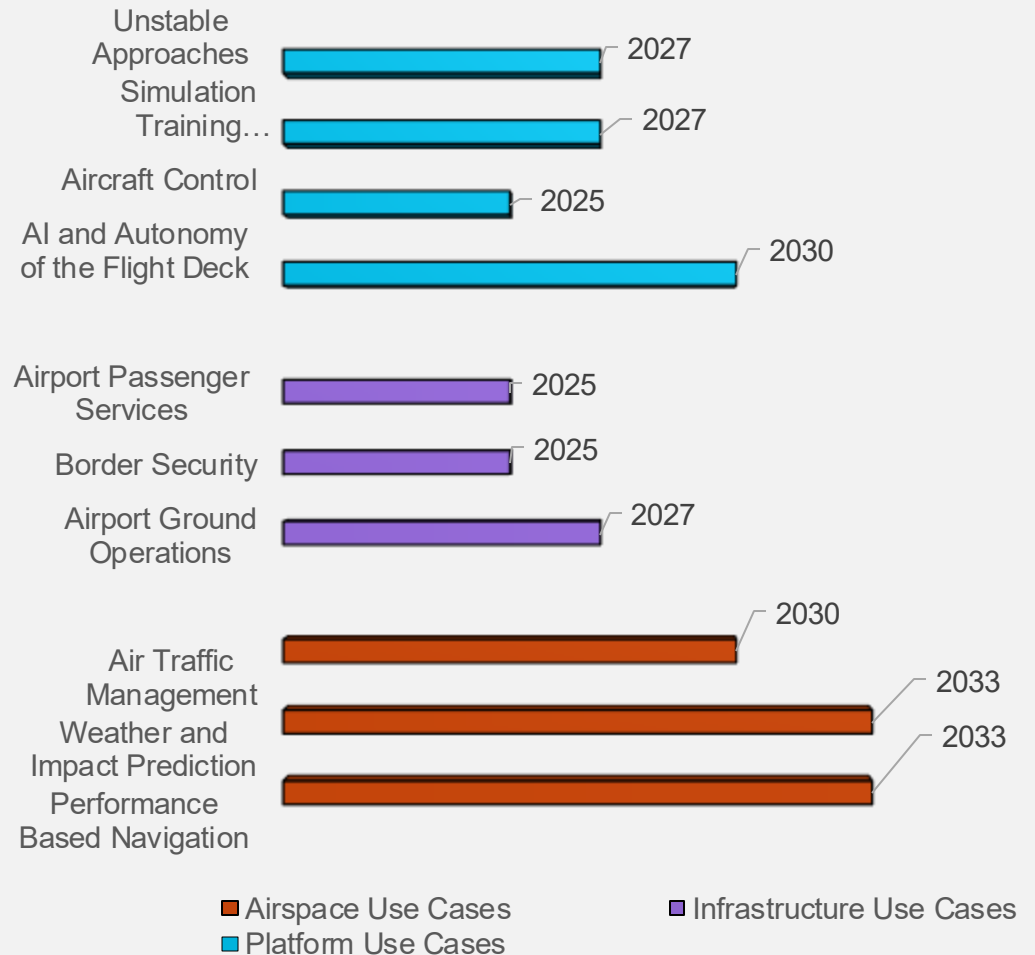
Timeline Outlook of Technologies

Our estimated trajectory reviews for integrating AI use cases within the aviation sector provide tentative guidance to regulators on areas to prioritize for rule-making activities. We welcome feedback to refine and inform our judgment.

Our focus centres on providing an insight into the timeline outlook of industry's maturity on specific use cases. This analysis serves as a valuable resource for understanding the evolving landscape and potential support we can provide the industry from a regulatory perspective to aid in the advancement of AI development.

It is essential to recognize the inherent uncertainty associated with predicting dates. Factors such as technological advancements, regulatory changes, and unforeseen challenges can impact actual implementation timelines.

As the industry evolves, our analysis aims to offer valuable insights, but readers should exercise caution and consider the dynamic nature of the aviation landscape

Estimated Timeline of AI Use Case Implementation

Use Case	Year
Unstable Approaches Simulation	2027
Training…	2027
Aircraft Control	2025
AI and Autonomy of the Flight Deck	2030
Airport Passenger Services	2025
Border Security	2025
Airport Ground Operations	2027
Air Traffic Management	2030
Weather and Impact Prediction	2033
Performance Based Navigation	2033

■ Airspace Use Cases   ■ Infrastructure Use Cases
■ Platform Use Cases

What's Next?

The CAA's Strategy for AI will provide a 'north star' to guide how the CAA approaches the regulation of AI and autonomy, while also giving innovators guidance on how to prepare for engaging with the CAA.

Alongside this technology outlook publication, we have also provided further information on using a common language for AI (CAP2966) and on building trust in aviation AI using the 5 AI Principles (CAP2970).

In summer 2024 we will publish our first Strategy for AI, encompassing both how we regulate AI used in the sector, and how we use AI ourselves as an organization and as a regulator.

During this time, and beyond the publication of the strategy document itself, the CAA is open for engagement and discussion, and ready to listen.

Tell us what you think

We are keen to hear your views on the content of this publication. Please get in touch via the email address below.

To submit **feedback** please contact Horizon.Scanning@caa.co.uk

For more information on the **CAA's Strategy for AI**, you can contact us on StrategyforAI@caa.co.uk

Visit the CAA's AI webpage
for latest updates, publications, and advice
caa.co.uk/innovation/artificial-intelligence

How did we develop this document?

We have engaged with airlines, airports and ANSPs to understand how their outlook on the technology is aiming to provide a more assured and streamlined operation. AI is researched for the areas of the aviation sector that we regulate, as well as using AI to help us regulate more effectively and in how we work as an organisation.

To be proactive in the field of policy development, identifying the key technology use cases for AI and their estimated timeline allows the regulator to showcase where rulemaking is to be prioritised for AI application.

Technology outlook documents for emerging technologies also provide insight into where challenges are prominent for the most relevant applications of innovation. Understanding the key challenges, we aim to collaborate with the industry to understand how to overcome them for application in a safe and assured manner.