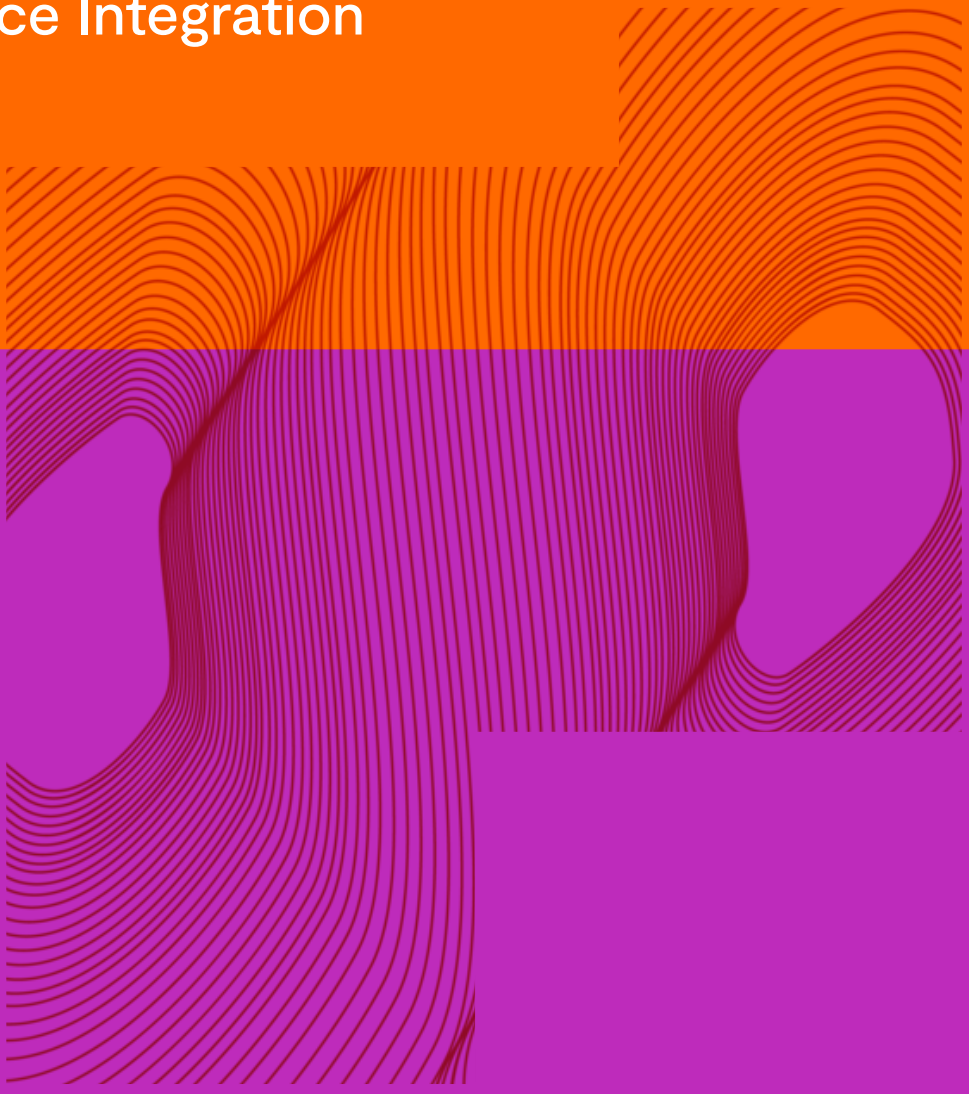
UK Research and Innovation

Let's get flying: Our plan for action

Future Aviation Industry Working Group on Airspace Integration



CATAPULT Connected Places

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1. Executive summary

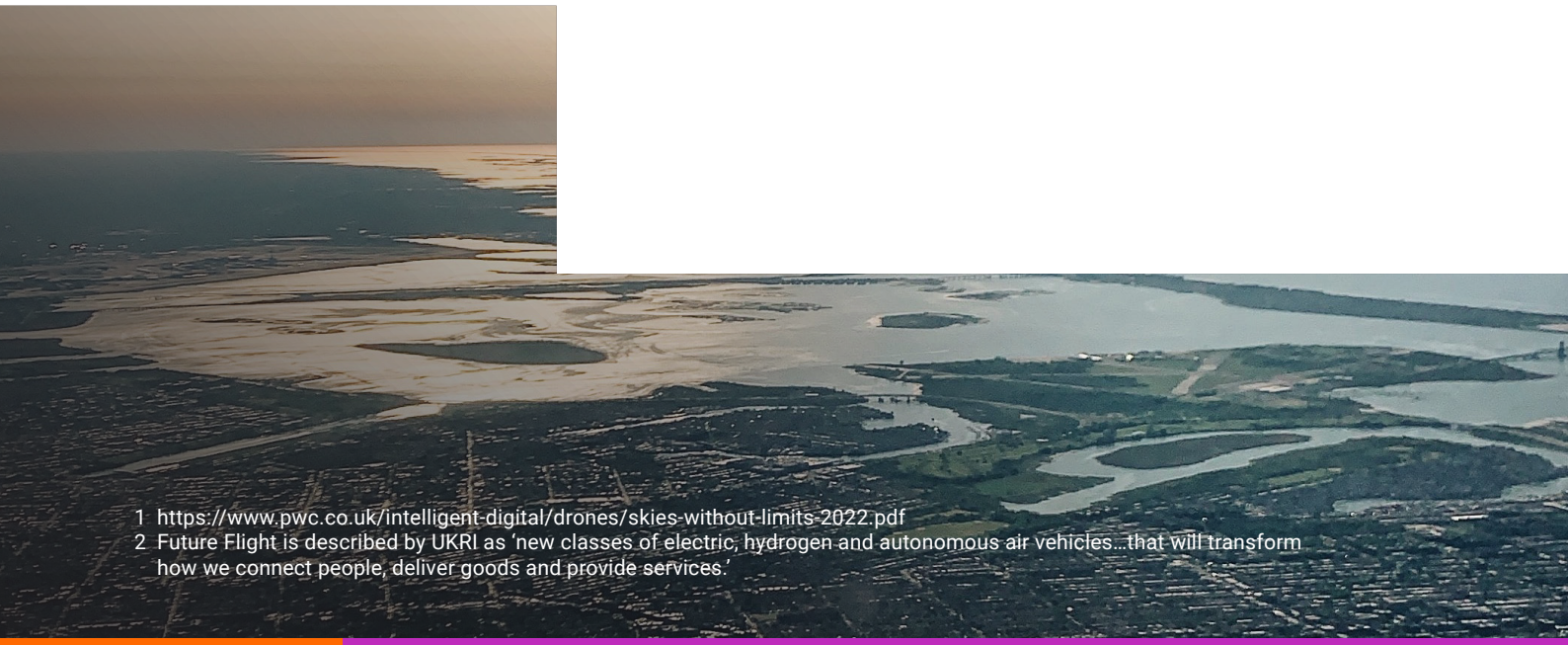
Technology is revolutionising the way we fly. Remotely piloted drones are offering safer, cheaper and faster services of a scope unimaginable a decade ago. Piloted electric vertical take-off and landing (eVTOL) aircraft are undergoing flight testing. These are quiet, zero-emissions aircraft, that will carry commercial passengers in just a few years' time. The economic and societal potential is very real and very large. The drone sector alone is predicted to provide a positive impact worth £1.6 billion per year to UK GDP up to 2030, amounting to £45 billion in total[1] and Future Flight[2] has the potential to cut carbon emissions and connect society across our regions.

We will only realise this potential if we can safely integrate these future aircraft into our airspace. Without commercially viable ways to fly, Future Flight ideas are no more than research projects. UK authorities deserve credit for identifying and responding to the need to adapt airspace and air traffic controls. The Airspace Modernisation Strategy (AMS) now reflects the importance of new aircraft, and Future Flight programmes and the Civil Aviation Authority's (CAA) Innovation Hub and Sandboxes are supporting innovation.

However, there is more to do to get flying at the scale required. The UK challenge for integrating Future Flight into airspace is less about awaiting technological breakthroughs or the need for fundamental legislation. Our challenge is to get a grip on the practical steps to launch and to dispel confusion, ambiguity and drift on airspace integration. We worry that having been a pioneer at the conceptual stage, UK commercialisation in the market is stalling and there is a risk the UK is falling behind its international competitors.

We believe we must get flying. We need to take meaningful steps safely to get real experience and data as quickly as possible. We need commercial services scaling by mid-decade. Only that way will we learn, develop robust safety systems at scale, and be able to build the commercial platforms to invest in further development.

This document is intended as a constructive plan, so industry can continue to work with other airspace users, government and the CAA to deliver the market's potential safely and unlock the barriers to airspace integration.



1 https://www.pwc.co.uk/intelligent-digital/drones/skies-without-limits-2022.pdf
2 Future Flight is described by UKRI as 'new classes of electric, hydrogen and autonomous air vehicles…that will transform how we connect people, deliver goods and provide services.'

Our plan is built around 3 themes, with 18 actions required over the next 3 to 5 years, with proposed “owners” and milestone targets. An overview of these can be seen in Figure 1, full details are in section 4. The main themes and recommendations include:

1. Accelerating speed to market

Timely changes are necessary to regulations on airspace, vehicles and safety cases, infrastructure, operating procedures, and emerging technologies to help businesses reduce risk and develop marketable services. The UK seeks to transition from airspace segregation for complex Uncrewed Aircraft System (UAS) operations toward a form of integrated airspace, but current regulatory processes for airspace changes of this type are complex and are a barrier to entry in the market. Stakeholder engagement and collaboration are essential to establish new processes that are proportionate and fit for purpose.

2. Establishing economic models

Growing Future Flight services and investment relies on progress towards sustainable economic models. Private funding is a big part of the future of the industry, but the broader financial frameworks across the airspace ecosystem are lacking in places. Clarity is required on funding mechanisms for the regulator to enable it to keep up with demand, and progress is required in establishing funding models for Electronic Conspicuity and scalable deconfliction services. While these frameworks remain unclear or uncertain, all players will struggle with securing the services they need and the confidence to invest.

3. Clarifying roles & responsibilities

Having clear roles and responsibilities across the industry is essential to progress from early development to a self-sustaining industry. For the UK, the AMS is the starting point to define these roles and responsibilities. However, the delivery mechanism for the program of work required for lower airspace in the AMS is currently undefined. The responsibility and funding for this program will need to be defined by the Department for Transport (DfT), in conjunction with the CAA. Fundamental aspects relating to provision of flight information and digital air traffic services also require clarity as to who will be required or enabled to provide such services.

The Future Aviation Industry Working Group on Airspace Integration (FAIWG:AI) was convened by UK Research and Innovation (UKRI) and Connected Places Catapult, co-sponsored by the DfT and CAA, to focus on the airspace integration challenges in Future Flight. We are comprised of around 20 leading established companies, emerging start-ups and industry bodies. We speak for ourselves, not our sponsors. We came together to identify the airspace barriers and issues holding us back and have developed this plan to address them. We have begun working with other airspace stakeholders across the aviation industry, and are now looking for further feedback .A revolution in flight, safer, quicker and greener, is not a mere dream, but it is not yet a reality in the UK either. This action plan proposes a way to help make it happen at a scale that will be of major benefit to the UK. Let’s get flying.

Photo credit: Vertical Aerospace

Figure 1: 18 steps to get us flying and the benefits they'll bring

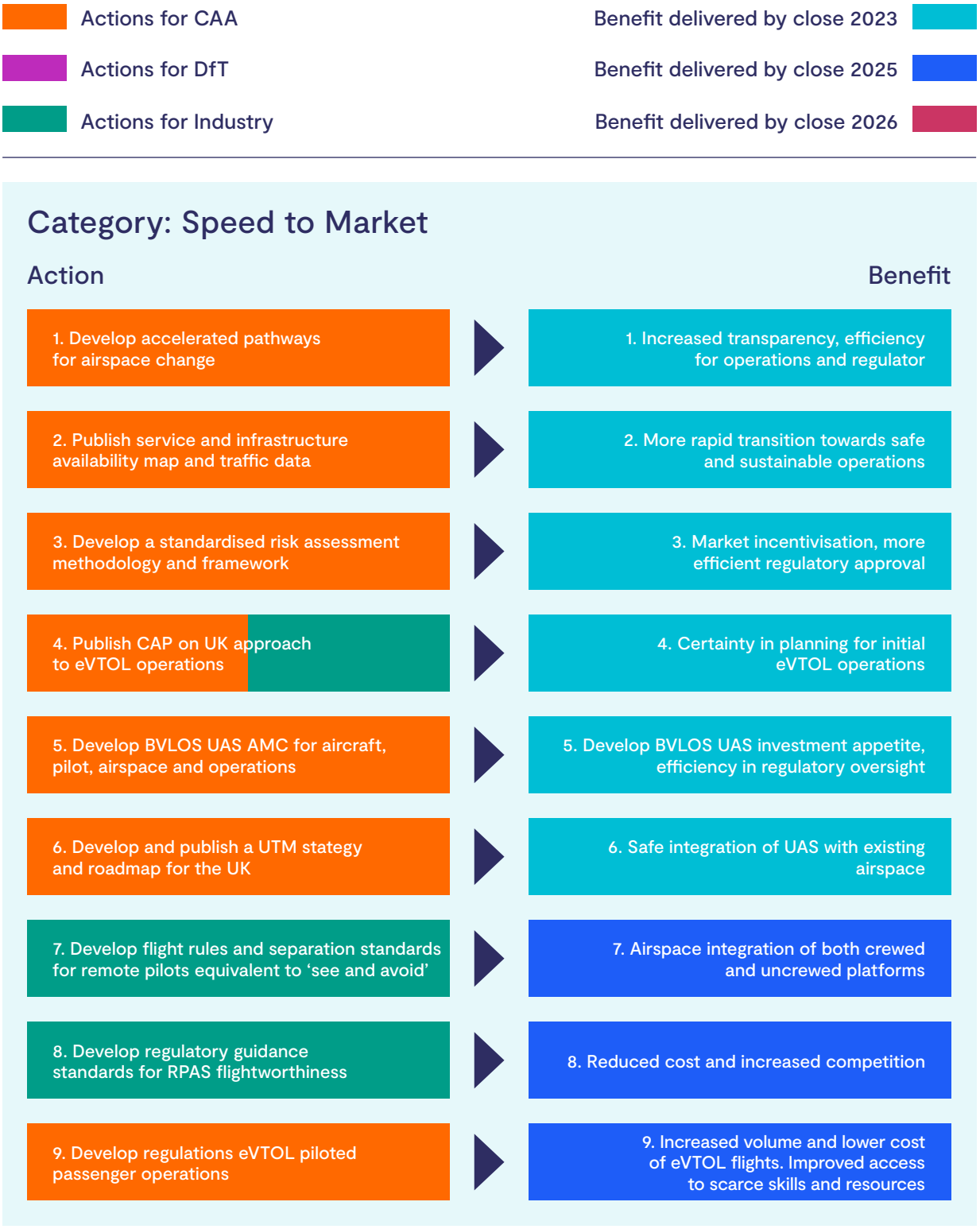


Figure 1: 18 steps to get us flying and the benefits they'll bring *continued*

Actions for CAA

Actions for DfT

Actions for Industry

Benefit delivered by close 2023

Benefit delivered by close 2025

Benefit delivered by close 2026

Category: Establishing Economic Models

Action	Benefit
10. Determine funding for ICAO FIS in UK	10. Airspace integration of both crewed and uncrewed platforms, clarity for FIS providers
11. Develop EC performance standard	11. Transparency enables ANSPs to invest in infrastructure
12. Develop safe and economically viable standards for BVLOS UAS pilot training	12. Achieve safety levels necessary to unlock airspace integration solutions
13. Update framework for fees on airspace change applications to include future flight operators	13. Increased operational certainty. Manageable workload for regulator. Greater ability to recruit necessary skills/resources
14. Develop and standardise future Air Traffic services to support automated deconfliction	14. Enable increased volumes of air traffic through increased use of automation
15. Conduct public consultation concerning mandate of EC	15. Business case for local level integrated airspace. Reduced risk. Fair airspace access for all users

Category: Clarifying Roles and Responsibilities

Action	Benefit
16. Identify roles, responsibilities, timelines and funding for delivery of the AMS lower airspace vision	16. Government commitment to AMS delivery, resulting in market confidence and increased innovation
17. Define policy for national level flight data distribution	17. Level playing field with equitable access, assured privacy and safe operations
18. Develop and provision FIS-B, or equivalent digital services and endorse through regulation	18. Reduced cost of service provision and greater abilty to support airspace integration

2. Context: who we are, our purpose and approach

2.1 Who we are

The FAIWG:AI was convened at the end of 2021 by UKRI and Connected Places Catapult. The DfT and CAA are co-sponsors. The group brings together stakeholders from industry to help provide input and insight to government strategy and regulatory policy for integrating new air vehicle types in UK airspace.

The emerging vehicle types represented by FAIWG:AI are:

- uncrewed aircraft systems and drones
- advanced air mobility (AAM) such as eVTOLs
- hybrid, hydrogen and electrical regional aircraft

An expression of interest process was run by the founding entities to establish broad representation across industry associations, technology companies and a range of other relevant areas. Members are a deliberate mix of leading established companies, emerging start-ups and industry bodies, with diverse perspectives on airspace issues across the emerging Future Flight industry and value chain. Members have cross-cutting expertise on flight operations, aircraft technologies, airspace management, regulations and standards. Members have drawn on their own organisations and networks, and other airspace user communities to best represent this sector.

The members from industry and academia have worked together to define this plan, engaging with the CAA and DfT, other industry groups and other airspace users. However, this document represents only the views of its members, and not the DfT or CAA.

We are consciously independent and industry led, precisely to provide a different perspective. In addition, this group, and the resulting plan, are focussed solely on the challenges for airspace integration. There are additional important barriers to commercialisation in Future Flight that need to be overcome, but these are outside the scope of FAIWG:AI work.

FAIWG: AI members 2022

- Aerospace, Defence, Security and Space group (ADS)
- Airport Operators Association (AOA)
- Altitude Angel
- Animal Dynamics
- ANRA Technologies UK
- Association of Remotely Piloted Aircraft Systems (ARPAS)
- BT
- Cranfield University and the Drone Industry Action Group (DIAG)
- EasyJet (member also representing the Institute of Engineering and Technology)
- Flylogix
- Industry Coordination for the Airspace Modernisation Strategy (ICAMS)
- Loganair
- National Air Traffic Service (NATS)
- Shared Airspace Council (member also representing University of Southampton)
- Skyports
- Vertical Aerospace
- Volocopter

2.2 What problems need to be solved?

FAIWG:AI published a 'problem statement' in August 2022 to set out the challenges we saw in airspace integration, that are blocking the potential for new classes of air vehicles in the UK.[3] The problem statement aimed to highlight these vital issues to the UK government. It also called for input from stakeholders across the aerospace and aviation industries to support the development of this plan and help address the problems.

The problem statement focused on 3 areas of restriction or challenge for Future Flight:

1. Regulation

- inertia in the development and adoption of new regulation that will enable the safe, secure and environmentally sustainable, assured operation of new technology.
- an acute lack of resource or upgraded processes in the regulator to address the demand from industry for new regulation and supporting guidance on compliance

2. Technology

- lack of standardised approaches to the delivery of technology to meet existing and new regulations for these new aviation use cases
- lack of the supporting built environment, energy, and digital infrastructure to develop and demonstrate this technology

3. Operations

- difficulty in beginning operations in integrated airspace because of potential issues with societal and governmental support
- the availability of personnel and infrastructure to support operations

We are proposing a plan, delivered by and through both government and industry, to address these problems so that we can deliver safe airspace integration for the future of aviation and unlock the associated economic, societal, and environmental benefits.

3 https://www.ukri.org/publications/future-flight-working-group-problem-statements/

2.3 Principles behind the plan

This plan is intended as a constructive proposal for industry, government and the CAA that addresses the problems identified. It is deliberately action oriented and direct in providing practical steps to move our industry forwards. We have developed the actions, and the work that sits behind them with the following strategic principles in mind:

Safety

Above all, the group recognises that the industry needs to adapt to change in a safe and sustainable way. The public expects and deserves to maintain or improve the level of safety for commercial flight that is achieved today in the UK, where it is often one of the safest forms of travel.

Market led

As commercial players many of us bring a sense of urgency with launching new forms of flight, as we seek to build our businesses. We think a commercial-led approach to airspace issues increases the UK's chances of maximising the potential of Future Flight, and this plan is therefore purposely market led.

Constructive

We intend to be constructive. We see government, the CAA, and other airspace users as core to our success. They are vital to help us operate safely, commercially and move at speed. Authorities must decide, enable and regulate. We genuinely appreciate the leadership and support seen in the UK. We know there are some trade-offs to be made, for example around the topic of Electronic Conspicuity. We want to help solve those dilemmas not simply demand others do. We recognise the desires and needs of other airspace users and the need for regulators to allow fair access for all to our airspace.

Pragmatic

We want our proposals and debates to be pragmatic. We have aimed to develop concrete, clear and detailed actions that can be implemented. We have deliberately tried to steer away from too many debates on concept, principle or the long-term future. Some of those will become important in time but we have decided that we cannot address them unless we get flying and building businesses first. We think that many of the principles established in the Airspace Modernisation Strategy are sound. We do believe, for example, that the long-term approach to airspace needs to be integration, not segregation. Only integration will create the capacity for all uses of the air over time. So, while there may be pragmatic benefits to limited segregation in the short-term, we support a drive toward an integrated future.

At pace

Our plan emphasises step changes to quickly get flying and build understanding. Safety of course comes above everything else. Beyond that, we think decisive action that allows operators to use UK airspace commercially sooner is the most important challenge, rather than creating a perfect new airspace system. Currently we believe that there are services that are being held back, that could safely operate with a few moves to clarify and simplify regulations.

2.4 Our approach

This plan has been developed through a structured approach, using real scenarios to validate the challenges and opportunities highlighted in the problem statement through stakeholder engagement with both existing airspace users and new entrants.

To inform the plan, 3 Minimum Viable Propositions (MVPs) were developed. These are propositions which are attracting early-adopter customers and validate an idea early in the product development cycle. They cover the following applications, which we believe are representative of current market demand:

1. Beyond the Visual Line of Sight (BVLOS) operations: remote surveillance, such as wind turbine or power line inspection or environmental survey

2. BVLOS operations: point-to-point cargo delivery, such as medical delivery networks

3. Piloted eVTOL operations: such as carrying passengers between city and airport locations

The MVPs elicited the main opportunities and challenges faced by industry in achieving a viable commercial business based upon a pragmatic and short-term approach. In each we have tried to zero in on the practical steps to get flying and set out what the specific current processes, rules or related factors are that are holding businesses back. The MVPs also provided an effective tool for industry engagement and validation of the opportunities and challenges and what is needed, in the next 3 to 5 years. Further work will be required in 2023 to understand the longer-term actions for truly scalable businesses beyond this timeframe.

Finally, this action plan has been developed with an open approach. We want to discuss and engage on the issues we've set out and intend for this plan to become a living document which is updated.

3. What is at stake?

Much is at stake for the UK in having our airspace ready to launch a commercial Future Flight industry by mid-decade. Practical action to implement necessary steps toward integration is important because of the size of the economic, societal and environmental opportunity. Action is urgent because of the stage the Future Flight industry is at and the speed with which progress is being made in other leading markets. Please refer to the Appendix for further detail on what airspace integration is, and the need for urgent reform.

3.1 How large is the opportunity?

Drones, eVTOLs and similar new forms of flying are on the cusp of becoming a significant, fast growing economic opportunity at a time when the country is seeking new growth. They offer tangible societal benefits, in creating new connections with underserved areas or closing gaps in existing infrastructure or delivering new community services. This emerging industry is also a low or zero carbon form of transport at the leading edge of decarbonising of flight.

Government has acknowledged the scale of the economic opportunity in the 'Flightpath to the Future' framework with its 10-point plan, particularly action point 5 to 'capture the potential of new technology and its uses'.[4] It also recognised in 'Advancing Airborne Autonomy' the potential for a £45 billion GDP uplift by 2030 from drones alone.[5]

PWC's 'Skies without Limits' report forecasts drones can deliver £22 billion in cost savings across multiple UK industrial sectors, using over 900,000 drones and with over 270,000 jobs associated with drone adoption and 650,000 jobs positively affected by them in the same time frame.[6]

eVTOLs similarly offer significant economic potential. Morgan Stanley forecast a global air taxi market revenue of $3.7 trillion by 2050.[7] Roland Berger forecasts potential for over 900 eVTOLs to be operating in the UK by 2035, which Vertical Aerospace estimates as a UK market for eVTOL services of £1.3 billion by that year.[8] UKRI estimated AAM applications to have the potential to add up to 1.8% to UK GDP by 2030.[9] These forecasts all point to the sheer scale of the economic opportunity over the next decade and beyond from the revolution in flight.

4 Flightpath for the Future, Department of Transport, 2022. p.38. https://www.gov.uk/government/publications/flightpath-to-the-future-a-strategic-framework-for-the-aviation-sector
5 Advancing Airborne Autonomy, Departments for Business and Transport, 2022. p.6. https://www.gov.uk/government/publications/advancing-airborne-autonomy-use-of-commercial-drones-in-the-uk
6 Skies without Limits, PWC, 2022. https://www.pwc.co.uk/issues/emerging-technologies/drones/the-impact-of-drones-on-the-uk-economy.html
7 Morgan Stanley eVTOL/Urban Air Mobility TAM Update, Morgan Stanley, 2021. https://www.morganstanley.com/ideas/autonomous-aircraft
8 The Future of Advance Aerial Mobility, Vertical Aerospace, 2021. p.16. https://vertical-aerospace.com/vertical-aerospace-calls-on-uk-government-to-enable-electric-intercity-flight-by-2025/
9 Future Flight Vision and Roadmap, August 2021, UKRI. https://www.ukri.org/publications/future-flight-vision-and-roadmap/

It is not just money at stake. Research and early operations have highlighted the societal and environmental value from Future Flight. Remote or poorly served communities can be connected far faster and at lower cost than with traditional transport links.

For example Windracer's scheduled drone service to deliver up to 100kg payloads of medical supplies and mail to island communities in the Orkneys, Fair Isle and the Isles of Scilly[10], or the Isle of Wight NHS supply service in the Solent Future Transport Zone providing direct supply of chemotherapy drugs.[11] Equally compelling in terms of linking the UK is the more than halving of journey times illustrated by proposed eVTOL services linking Glasgow and Belfast or Liverpool and Hull.[12] From search and rescue to infrastructure inspection and airport passenger shuttle services to urban areas these new aircraft are allowing us to plan radically better ways to serve people or totally new services connecting our society. They also offer a safer way to do so.

Removing humans from dangerous work, improving safety surveillance or reducing the risk for passengers potentially over 12-fold versus travel by helicopters when using an eVTOL.[13]

The final compelling opportunity at stake is supporting the race to net zero. PWC estimates that drones alone should save 2.4 million tonnes CO2 equivalent by 2030.[14] eVTOL emissions are equivalent to electric vehicles over most UK journeys analysed by Vertical Aerospace, and lower than even rail alternatives in a significant number of cases.[15] New, low carbon propulsion systems are being developed for smaller commercial airliners, which will offer passenger capacity between that of eVTOLs and conventional regional airliners.[16] Growth in this sector of the market will potentially change the established economics of sub-regional domestic air travel and allow the core, low carbon technologies to scale and mature quickly. That means they can be used on larger aircraft sooner than might otherwise be the case.

Given the urgency of cutting emissions, these immediate opportunities for reductions should not be ignored even as Future Flight paves the way for new ways to cut carbon in flight, ground transport and elsewhere.

Photo credit: Skyports

10 https://windracers.org/get-up-to-speed/
11 Advancing Airborne Autonomy, Departments for Business and Transport, 2022. p.20 and Skies without Limits, PWC, 2022. p. 23-24.
12 The Future of Advance Aerial Mobility, Vertical Aerospace, 2021. p.11-15
13 The Future of Advance Aerial Mobility, Vertical Aerospace, 2021. p.25
14 Skies without Limits, PWC, 2022. p.3
15 The Future of Advance Aerial Mobility, Vertical Aerospace, 2021
16 Flight Global, Cranfield Aerospace and Project Fresson, Jan 2022

3.2 Why is this opportunity at stake now?

Future Flight is not a theoretical opportunity for the UK. We have a promising emerging industry of start-ups and established players across the main areas of the sector, many leading the world in technology and innovation. FAIWAG:AI's members alone have raised well over $0.5 billion in private investment in the last 12 to 18 months to drive investment in their services, products and core technologies, the majority of it going into UK activity. Many of our members are already operating services on a commercial cost structure, for example drone operations in the North Sea.

Critically, our members and others across the emerging sector now need to launch commercially viable operations at scale within the next 2 to 5 years. Most, if not all, the companies we have engaged with report that they are targeting this window for the first wave of commercial services. Or indeed that they would be scaling up already if not held back by uncertainties around airspace or other rules and processes. Only by scaling up commercially can they drive the revenues, and ultimately the profitability and return on investment to continue to support building UK businesses.

The time to take practical steps to launch minimum viable commercial services is now or never. Either these growing British businesses move on to fly commercial operations at scale and flourish, or these innovative services will stall. Investment will dry up and our innovative firms must move outside of the UK to launch or wither.

This danger is real. For example, Amazon Prime Air pulled out of the UK for drone delivery service in 2022 despite starting worldwide trials in Cambridge in 2016.[17] This was in large part because airspace and other complexities made concrete action hard and business planning difficult. Amazon Prime Air has now gone to the US and elsewhere with the next stage of its drone business expansion.

The rest of the world is not standing still. The U.S, Europe and the advanced economies of Asia are pushing ahead with airspace plans and wider rules to get their industries flying. Both the European Union Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA) are pushing ahead in early 2023 with practical implementation of new rules such as EASA's U-space regulation.[18] Further examples include Japan, with a government and private panel focused on flying eVTOLs and drones for the 2025 World Expo,[19] or Korea with its Grand Challenge to fly by 2024.[20] Countries are forging ahead in a very concrete way, and there is a danger the UK falls from being a pioneer to a laggard in Future Flight.

The UK has a well-articulated strategy for Airspace Modernisation, which in our view, is based upon the correct principles of integration (see Appendix). In the UK we have led much of the conceptual thinking on Future Flight and airspace, and early trials and demonstrations of the technologies and concepts. Government deserves credit for fostering that head start. What is at stake now is realising the economic, societal and environmental potential in the second half of the 2020s and into the 2030s. That will require action from government, regulators, and industry.

17 Skies without Limits, PWC, 2022. p.21
18 https://www.easa.europa.eu/en/document-library/general-publications/understanding-how-new-u-space-will-enable-safe-integration
19 https://www.expo2025.or.jp/en/news/news-20221227-01/
20 http://en.kuam-gc.kr/

4. Proposed actions

Our plan, as captured in the 18 actions, is composed of 3 themes.

4.1 Accelerating speed to market

Timely changes are necessary to regulations on airspace, vehicles and safety cases, infrastructure, operating procedures and emerging technologies to help businesses reduce risk and develop marketable services. For an emerging industry, with limited or no current revenue and a finite stock of investment, speed to market is vital for survival and growth. This need for speed cannot be overlooked in a UK market that in the past has often been strong on good intentions and strategic concepts and slow on implementation relative to competitors and peers.

Consulting, developing, and implementing these interventions must be a collaborative activity between policy makers, regulators and industry. This will instil confidence in the approach and solutions and help speed up market readiness.

The UK unmanned aviation sector has been maturing its operational readiness through both regulatory and technology initiatives such as the Drone Pathfinder Programme, Future Flight Challenge and other industry funded projects supported by the CAA innovation programme. The DfT and the CAA have published aviation strategies such as Aviation 2050 and the AMS which give direction to support this growth, even if more details are needed on implementation.

The UK seeks to transition from airspace segregation for complex UAS operations toward a form of integrated airspace. This is envisaged initially as solutions such as Transponder Mandatory Zones (TMZ), to allow scalable UAS operations. Current regulatory processes for airspace changes of this type, and related vehicle and operational safety case processes, are complex and are a high barrier to entry for all in industry, particularly new entrants. Stakeholder engagement and collaboration are thus necessary to establish new processes that are proportionate and fit for purpose.

There are also clear gaps currently in regulation or guidance for the introduction of eVTOLs into airspace that are key to enabling commercial services for these aircraft. The barriers that most directly relate to airspace are how they will be able to operate in existing airspace constructs for initial operations and the standards required for pilots onboard or remotely.

Alongside creating clear, practical and effective regulations, communicating them to industry alongside the acceptable means of compliance is vital. Industry needs to see the pathway to implement the whole suite of new regulation, guidance and standards both so that they can support and engage with regulators and to give clarity for their own strategic business decisions.

For example, in Europe, EASA formed a rule-making task force 5 years ago to help evolve regulations and inform the sector, through regular publications of the regulatory approach and gaps to be bridged. Development of a common UK aviation framework for all airspace users will need a holistic approach on market, technology and regulatory readiness.

Adopting these principles underpinning speed to market has many benefits:

- addresses ambiguity in the current and future desired regulatory state, particularly on airspace and new traffic management technologies such as UTM
- informs stakeholders of the interventions and dependencies for airspace integration
- reduces technology, investment and operational risks facing existing and new entrants
- accelerates market uptake because of simpler approval processes.

Ref.	Issue	Action	Benefit	Owner	Delivery
1	Airspace change process (ACP) under CAP1616[21] is lengthy, requiring multiple engagements and often repeat ACP applications. This is currently a problem for UAS operators. This may also affect eVTOL operations in the future, as some vertiports may be away from existing aerodromes.	Develop accelerated pathways for airspace change that supports the vision for lower airspace in the refreshed AMS. This needs to include pathways to support both UAS, for example TMZs, and eVTOL requirements. Define acceptable means of compliance within those pathways.	Increased transparency, reduced timescales and reduced resource requirements on both operators and regulator.	CAA	2023
2	Lack of awareness of existing infrastructure and services across the UK, together with their relevance to the new class of operations.	Publish service and infrastructure availability map and traffic data to support operator planning of new classes of vehicles.	More rapid transition towards safe and sustainable operations.	CAA	2023
3	Uncertainty amongst operators on how to deliver UAS safety case in a way that can enable rapid and transparent regulatory approval.	Develop a standardised risk assessment methodology and framework and extend pre- defined risk assessments (PDRA).[22] Adopt usage of digital data in that framework to enable rapid assessments of operational applications.	Removal of constraint on market and encouragement of new entrants. Reduced time taken for regulatory approval.	CAA	2023

21 https://publicapps.caa.co.uk/cap1616
22 https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=11731

Ref.	Issue	Action	Benefit	Owner	Delivery
4	Lack of regulatory guidance on the operation and airspace usage of eVTOL aircraft which possess different performance and manoeuvrability compared to conventional helicopters. It is expected that they will initially need to be accommodated within existing frameworks for conventional helicopters, but this is not defined.	The CAA eVTOL safety leadership group to identify and publish a Civil Aviation Publication (CAP) on the UK's approach to operations of eVTOL aircraft, including airspace usage. This should have an initial focus using existing regulation but should also identify future regulation changes required to avoid limiting future operations.	Clarity and direction to the industry and businesses on applicability of existing guidance, and additional measures necessary to support initial operations.	CAA / Industry	2023
5	Remotely Piloted Aircraft Systems (RPAS) operators are required to submit a bespoke safety case covering complete system (aircraft, pilot, airspace and operations) every time an application for BVLOS permissions are made. This is increasing burdens upon operators and constraining the market.	Develop acceptable means of compliance for each of the pillars of BVLOS: aircraft, pilot, airspace and operations to enable standardisation and specific oversight, consistent with existing Safety Management System (SMS) frameworks.	Greater transparency and reduced burden on applicants, leading to increased investment appetite. Increased standardisation and clarity of regulatory oversight.	CAA	2023

Ref.	Issue	Action	Benefit	Owner	Delivery
6	CAP 722[23] identifies Uncrewed Aircraft System Traffic Management (UTM) as an enabling service for RPAS operations, however the lack of a strategy and roadmap on UTM technologies or U-space increases uncertainty in its application and adoption.	Develop and publish a UTM strategy and roadmap for the UK.	UTM facilitates safe RPAS integration by enabling data exchanges at a strategic and tactical level with Air Traffic Management (ATM) therefore bridging many known gaps.	CAA	2023
7	Airspace integration of crewed and uncrewed aircraft depends upon new flight rules to achieve the same safety levels as 'see and avoid'.	Develop, through trials, new flight rules and separation standards for remote pilots to show equivalence to 'see and avoid'.	Necessary to achieve basis of airspace integration between crewed and uncrewed platforms.	Industry	2024
8	Lack of clarity on RPAS safety case and flightworthiness guidance outside the Open category[24] hindering investment and delaying operational introduction.	Develop or endorse regulatory guidance and acceptable standards for RPAS flightworthiness, ideally aligned with international norms for example Specific Operations Risk Assessment (SORA)[25] and design verification standards.	Reduced investment and increased competition.	Industry	2025
9	Lack of pilot standards for eVTOLs and passenger carrying aircraft is increasing market uncertainty.	Develop and publish regulations for certified piloted eVTOLs and operating rules for airlines operating eVTOLs remotely with passengers on board.	Increased volume and lower cost of eVTOL flights. Improved access to scarce skills and resources.	CAA	2025

23 https://publicapps.caa.co.uk/cap722
24 For further information on UK drone regulations and categories see https://www.caa.co.uk/drones/
25 For further information on SORA see https://www.easa.europa.eu/en/domains/civil-drones-rpas/specific-category-civil-drones/specific-operations-risk-assessment-sora

4.2 Establishing economic models

Growing Future Flight services and investment relies on progress towards sustainable economic models and clarity on who pays for underlying costs. There has been significant investment from government, for example through UKRI's Future Flight Challenge, and private industry on early development and demonstrations.

However, public funding will currently end during 2024 and there is an expectation that organisations will have proven technology and safety to a point of commercialisation. Private funding is a big part of the future of the industry, but the broader financial frameworks across the airspace ecosystem are lacking in places. While these frameworks remain unclear or uncertain, all players will struggle with securing the services they need and the confidence to invest.

Clarity is required across several categories affecting different members of the ecosystem, where if we do not look at them holistically, we will create bottlenecks to progress. The work will need to provide clarity for the regulator on its own funding mechanisms to enable it to keep up with demand. It must allow operators to understand training requirements to build relevant skills and understand costs. It must also tackle head on large issues such as who funds Electronic Conspicuity and scalable deconfliction services, as they have great potential to deconflict and open up airspace, but also create risks on the future costs to operate.

Providing clarity on these items will enable the relevant stakeholders to forecast and define appropriate business models and end-user pricing more accurately. This, with progress across other actions in speed to market and roles and responsibilities, will enable the industry to start to become profit generating. That cuts our dependency on venture capital or government backing to create a self-sustaining cycle. If the UK does not have this clarity in economic models in the next 2 to 3 years we are convinced money will move elsewhere or current operators will deploy outside the UK.

Ref.	Issue	Action	Benefit	Owner	Delivery
10	Airspace Modernisation Strategy has highlighted a need for UK wide International Civil Aviation Organisation (ICAO) Flight Information Service (FIS) provision. Current service is provided by multiple providers across the UK.	Determine means of funding and implementation of ICAO FIS at national level as per the AMS. Ensure that the identified owners are given the formal mandate to implement.	Necessary to achieve base level of airspace integration between crewed and uncrewed platforms. Provides clear requirements for current FIS providers.	DfT	2023
11	Investment in infrastructure to enable Electronic Conspicuity (EC) is being held back by lack of a performance standard.	Develop EC performance standard based upon specific operations, supported by safety analysis of detect and avoid measures.	Increased transparency and provides basis upon which Air Navigation Service Providers (ANSPs) could invest in new or replacement infrastructure to support operations. Consistency with international standards for example Eurocae.	CAA / Industry	2023
12	Shortage of pilots with appropriate skills necessary to support certain operations for RPAS.	Develop safe and economically viable standards for pilot training to support specific BVLOS operations for RPAS.	Achieve safety levels necessary to unlock airspace integration solutions.	Industry	2023

Ref.	Issue	Action	Benefit	Owner	Delivery
13	CAA does not receive any direct funding to support approval of ACP applications under CAP1616 for example Temporary Danger Areas (TDAs) and TMZs. Workload is increasing and skills and resources are scarce.	Update ORS5 scheme of charges[26] that apply to airspace change applications by all sponsors, including future flight operators, with commensurate service commitment from CAA.	Increased certainty of planning and expectations for operators. Manageable workload for regulator. Greater ability to recruit necessary skills/resources.	CAA	2023
14	Lack of air traffic services and data to support automated deconfliction for high volume RPAS and eVTOL flights leads to reduced capacity.	Develop and standardise future air traffic services to support automated deconfliction.	Potential for automation and increasing the number of RPAS aircraft per pilot. Migration from medium volume operations to high volume operations in specific blocks of airspace.	Industry	2026
15	Lack of widespread EC hinders integrated airspace.	Conduct public consultation concerning mandate of EC, with associated services, for operations across all aircraft and airspace, including both aircraft and ground-based equipment.	Clearer business case for integrated airspace at a local level. Reduced risk profile for all forms of detect and avoid capability. Fair airspace access for all types of users.	DfT	2026

26 https://publicapps.caa.co.uk/ors5

4.3 Clarifying roles and responsibilities

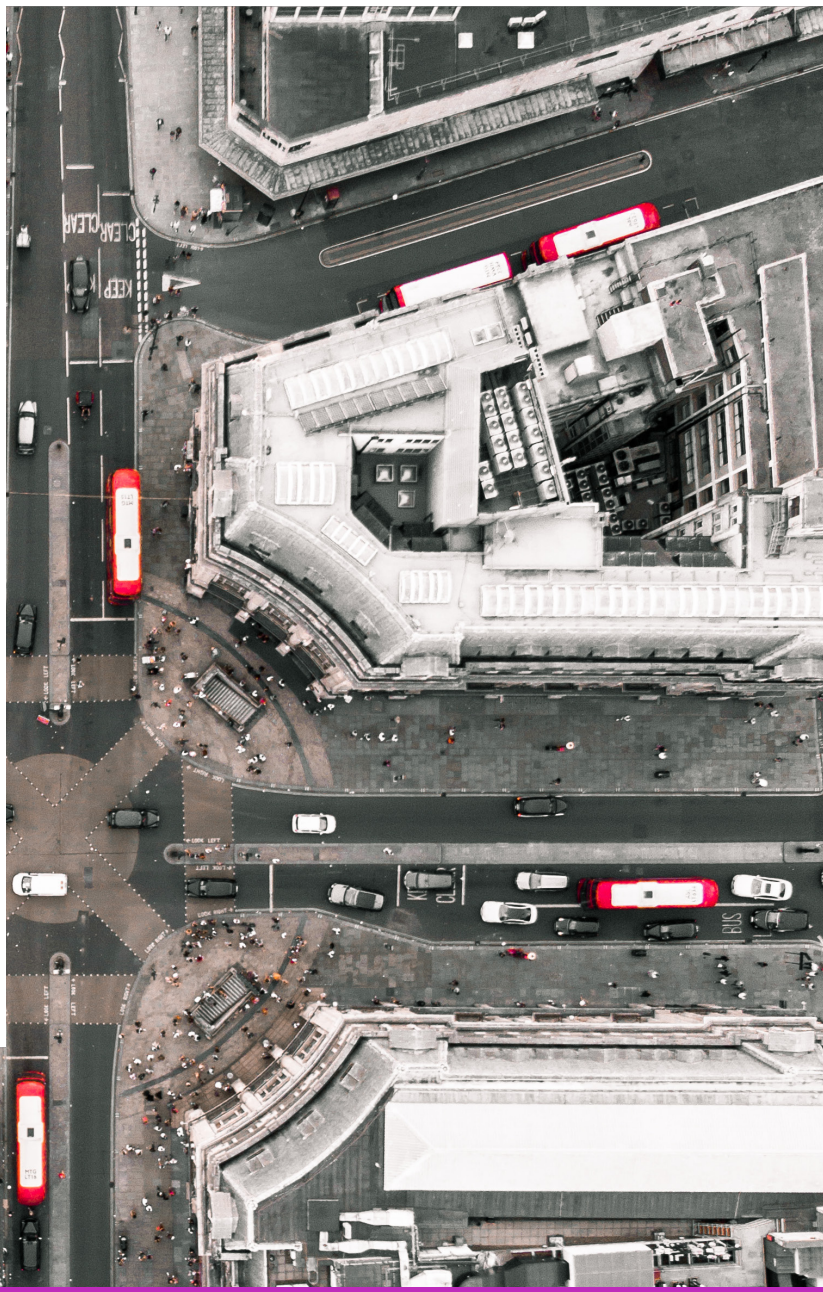
Having clear roles and responsibilities across the new industry is essential to progress from early development to a self-sustaining industry. For the UK, the Airspace Modernisation Strategy is the starting point to define these roles and responsibilities.

The refreshed AMS from the CAA is being published in January 2023. For the first time, this document sets out a vision for lower airspace. Including lower airspace is a key step forward, which recognises the current and future growth of air traffic for new vehicle types such as RPAS and eVTOL. Having made that step there are now numerous technology challenges and associated changes to regulatory processes and definitions required to enable operation of these vehicle types in airspace unsegregated from other aircraft. Therefore, a programme of work will be required to deliver the vision the strategy sets out.

The AMS is published in 3 parts, with parts 1 and 2 focusing on the intent and vision and part 3 focused on how they will be delivered. The refreshed strategy so far only includes parts 1 and 2. Therefore, the delivery mechanism for the programme of work required for lower airspace is currently undefined. The responsibility and funding for this programme will need to be defined by DfT, in conjunction with the CAA. For work to start in the required timescales, this needs to be discussed and agreed without delay and the relevant owner given the formal mandate to complete the work, with any additional funding requirements addressed.

If this is not completed, then there will be a delay in introduction of the required elements. This will inevitably mean delays to commercial services in the UK.

It is not just the AMS programme itself that requires clarification of roles and responsibilities. Fundamental aspects relating to provision of flight information and digital air traffic services also require clarity as to who will be required or enabled to provide such services. Flight information and data is crucial to enabling safe operation in an integrated airspace, but this data must be appropriately managed to maintain security so appropriate policies, responsibilities and frameworks must be developed.



Ref.	Issue	Action	Benefit	Owner	Delivery
16	The refreshed AMS published in January 2023 defines a vision for lower air space, which supports Future Flight, but no formal plan or defined resource accompany this vision.	Urgently identify clear roles, responsibilities, timelines and means of funding for delivery of the lower airspace vision within the refreshed UK AMS. This requires a specific lower airspace initiative in the AMS delivery plan to ensure the relevant delivery elements are rapidly targeted in a focused manner.	Government commitment to AMS delivery, resulting in market confidence and increased innovation.	DfT	2023
17	Absence of elements of vital flight data is inhibiting implementation at a local level. No consistent architecture within which to accommodate data securely between legacy and modern platforms.	Define policy for national level flight data distribution. CAA to then define framework for collaborative distribution of flight data using SWIM style semantics.[27] CAA to define accompanying architecture and security controls to enable scalable and distributed implementation that can evolve to meet market requirements.	Availability of data on a need-to-know basis is a critical step in implementation to ensure fair access, assured privacy and safe operations.	DfT	2023
18	Voice based Air Traffic Services reduce ability to support integration of uncrewed platforms.	Develop and provision Flight Information Service - Broadcast (FIS - B), or equivalent digital services and endorse them through regulation.	Reduced cost of service provision and greater ability to support airspace integration.	Industry	2026

27 https://www.eurocontrol.int/concept/system-wide-information-management

5. Next Steps

FAIWG:AI's impact and value relies upon the actions within this document being enacted effectively and at pace. To this end, FAIWG:AI will continue throughout 2023 to support their delivery and continue providing a conduit between industry, government, and the regulator.

Airspace integration is a challenge that no organisation or single group can solve on its own. There are diverse and valuable perspectives found across the future flight ecosystem about how best to tackle the challenges raised in this document.

Recognising this, the group would welcome feedback from any interested party across industry and other airspace users on the following questions:

- Have we identified the UK's core airspace integration challenges?
- Do the actions outlined in this document go far enough in providing practical steps to move the industry forwards and do they overcome the challenges?
- Are there additional cross-industry opportunities that FAIWG:AI, its co-sponsors and members could look to address?
- Are there other points of feedback we should consider?

Please consider filling in this **feedback form** to share your views on this document and the questions.

We would welcome questions or support for either this plan or FAIWG:AI's work and can be contacted via **david.pounder@cp.catapult.org.uk.**

6. Appendix: The principles of integrating airspace

6.1 What is ‘airspace’ and how is it currently run?

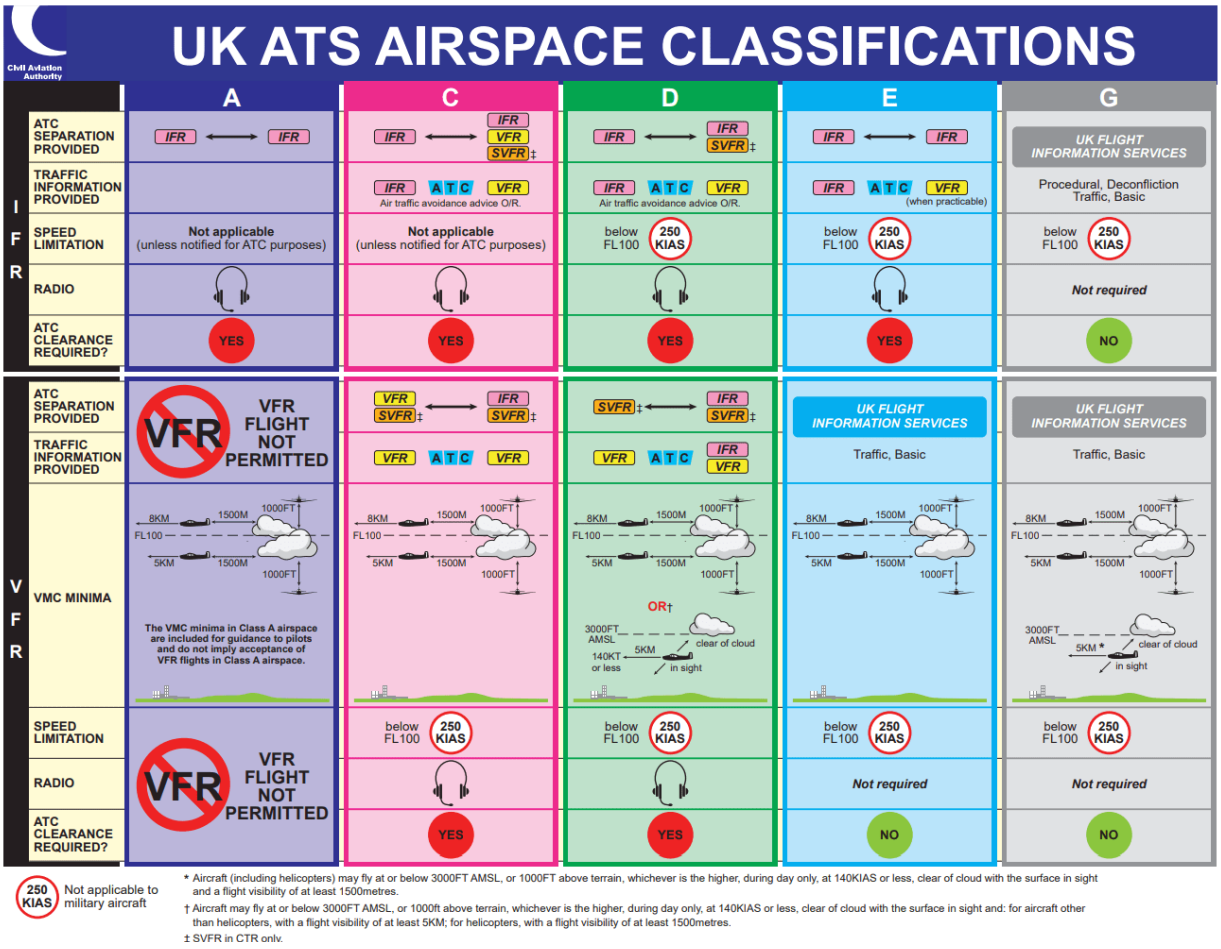
UK airspace is an essential, but largely invisible, part of our national transport infrastructure. It is a shared and, in certain regions, scarce resource. Rules for who can fly where, when and how, are needed to allow safe flying. These rules and processes together make up airspace and the air traffic control that operates the airspace. New classes of user mean airspace, its operation and the way different classes fly need to be clear to new and existing users. For example, drone operations mean a big expansion in uncrewed flight where there is no pilot on board to adapt to events in the sky. Likewise, eVTOLs may be piloted but will fly at lower altitudes and in greater numbers than current aircraft.

Currently airspace segregation is applied in UK airspace. This segregation is primarily there for safety reasons while meeting the existing needs of users. The segregation structure specifies the routes that aircraft fly and the procedures and systems used by air traffic services to manage traffic flows.

UK airspace is divided into controlled and uncontrolled airspace. Aircraft in controlled airspace fly under the positive monitoring and direction of air traffic control to maintain safe distances between them. Uncontrolled airspace typically incorporates areas where aircraft are not identified and managed by air traffic control, although they may request a limited service that can provide information and advice to support a safe flight. Airspace is further divided into classifications that describe the flight rules for those operating in that airspace.

The following diagram provides a summary of the services and obligations that apply within each class of airspace in the UK today.

Figure 2: UK ATS Airspace classifications and service applicability[28]



250 KIAS Not applicable to military aircraft

* Aircraft (including helicopters) may fly at or below 3000FT AMSL, or 1000FT above terrain, whichever is the higher, during day only, at 140KIAS or less, clear of cloud with the surface in sight and a flight visibility of at least 1500metres.

† Aircraft may fly at or below 3000FT AMSL, or 1000ft above terrain, whichever is the higher, during day only, at 140KIAS or less, clear of cloud with the surface in sight and: for aircraft other than helicopters, with a flight visibility of at least 5KM; for helicopters, with a flight visibility of at least 1500metres.

‡ SVFR in CTR only.

The main parties responsible for the design of airspace are:

- NATS (En Route) plc (NERL), a subsidiary of NATS Holdings, which is the regulated monopoly air traffic services provider for enroute and some terminal approach airspace
- airport operators and localised air traffic services providers
- Ministry of Defence

The majority of commercial air transport flights operate in controlled airspace. General Aviation operates largely, but not exclusively, in uncontrolled airspace below 6,000 feet. The military also has requirements to use both types of airspace, to secure the UK's borders and carry out training, and also operates within the confines of segregated training or danger areas.

28 https://www.nats.aero/ae-home/introduction-to-airspace/

6.2 What does airspace integration mean?

There are 2 basic concepts of managing modern airspace: segregation and integration.

Segregation means dividing the sky into mutually exclusive blocks, with different rules for each, and in many cases, as shown above, excluding certain users from parts of the sky.

Segregation in the form of controlled airspace is currently used to assure the safety of commercial air transport flights in the UK. Segregation is also being used to safely experiment and demonstrate new aircraft of types of flying, for example by creating Temporary Danger Areas for testing new developments in. Elsewhere in the world some are proposing airspace segregation as the solution for all new forms of flying, for example this is the approach being taken by EASA with its U-space construct.[29]

The alternative to segregation is airspace integration. Airspace integration means that a variety of different user types are now sharing the same volume of airspace. Such users may include crewed and uncrewed aircraft. Technology and new approaches to air traffic control now make integration between traditional and emerging forms of flight conceivable in much of the sky.

If the UK does not move toward integration, we will need to strictly segregate the airspace according to user type and thereby ensure that crewed and uncrewed aircraft are kept apart through the definition of airspace classifications. This has a number of important disadvantages:

- reduced access to airspace for existing users, especially general aviation
- lack of flexibility as new applications and flight user cases emerge
- inability to support new uncrewed applications whose locations directly coincide with existing crewed flight patterns
- increased complexity of airspace combined with lack of visibility of and for some fliers and resulting impact on safety

Increasing segregation as Future Flight grows is likely to both radically reduce the availability of airspace for users and potentially increase safety risks. A balance is needed to satisfy the safety and economic requirements of various users. Requirements that can, at times, conflict. At lower altitudes there is more of a challenge in balancing requirements because there is a wider range of affected parties, potentially more aircraft and Future Flight is growing fastest at lower altitude.

Today's paradigms outlined above need to be adapted to safely accommodate the new variety of users and vehicles. This is why airspace integration is a significant challenge. It is a challenge that is not unique to the UK. The international ICAO standards on which the existing paradigm is based largely assume a single user type as dominant within each class of airspace. That user has certain well defined and accepted characteristics in terms of training and equipage which, along with specific flight rules, provide a safe basis for flight within that volume of airspace. Where there are exceptions to this broad rule, there exist specific Air Traffic Services (ATS) procedures to gain access to wider classes of airspace in certain circumstances.

FAIWG:AI believes that the UK should move toward integration. This may be a step-by-step process and there may be various points short of full integration in some classes of airspace. The principle of integration is also supported in the AMS.

29 https://www.easa.europa.eu/en/regulations/U-space

6.3 Why does airspace integration need new rules?

Airspace integration needs to be part of a comprehensive regulatory framework for eVTOL and UAS operations. If these other sets of rules are not put in place no scalable UK operations will happen and a UK UAS and eVTOL industry will not emerge.

The UK is currently missing a clear regulatory framework or development plan for commercial UAS and eVTOL operations.

The scale of future UAS operations will eventually require inclusion of digital traffic management through UAS Traffic Management (UTM), to enable efficient airspace integration of Airspace Traffic Management.

Other aspects of regulation, for example vertiport operations and permitting, will also have impacts on airspace processes. So too will the economic rules around air traffic services, airspace change processes and the like. Not having clear rules in development over the next 12 to 36 months creates critical uncertainty for future operators and manufacturers as costs. Performance and airspace equipage requirements for UK commercial operations also remain fundamentally unclear and unknown.

The UK has decided to develop its own proposals. These will be consistent with Europe's EASA rulemaking framework on UAS operation and eVTOL certification, but the UK will not implement the entire EASA regulatory framework. EASA has already released a complete workplan on published and upcoming rulemaking on UAS, UTM and eVTOL operation and certification and updated this in December 2022.[30] EASA is now developing momentum on this workplan. For example, in June 2022 EASA released an important draft with NPA2022-06 of a first set of operating rules for commercial eVTOL operators.[31] EASA released the Acceptable Means of Compliance and Guidance Material (AMC/GM) for the U-Space regulation, to be implemented across Europe on Jan 26 2023, in December 2022 and plan on a new NPA on BVLOS UAS operations in early 2023.[32]

The FAA in the US has already published its UAS BVLOS final report in March 2022[33] and their Low Altitude Authorization and Notification Capability (LAANC) service at more than 300 airports, is progressing UAS integration into airspace.[34] The FAA have announced their AAM strategy as a part of the agency's efforts to integrate new types of aircraft safely and efficiently into the US airspace system.[35] It is also providing a simpler pathway for applicants to obtain the necessary FAA approvals. Those initial announcements have been backed-up in November 2022 by publishing a Notice of Proposed Rulemaking (NPRM) that proposes to amend the regulatory definitions of air carriers.[36] The FAA has published proposed airworthiness criteria for Joby Aviation's JAS4-1, providing the first detailed US example of the certification basis for an eVTOL aircraft.[37] FAA is also working on releasing an interim "special federal aviation regulation" (SFAR) by the start of 2023 setting out how it intends to certify pilots and operations.[38]

30 https://www.easa.europa.eu/en/document-library/terms-of-reference-and-group-compositions/tor-rmt0230-0#group-easa-related-content
31 https://www.easa.europa.eu/en/document-library/notices-of-proposed-amendment/npa-2022-06
32 https://www.easa.europa.eu/en/newsroom-and-events/press-releases/easa-publishes-first-set-amcgm-u-space-regulation
33 https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information?documentID=5424
34 https://www.faa.gov/uas/getting_started/laanc
35 https://www.faa.gov/uas/advanced_operations/urban_air_mobility
36 https://www.faa.gov/newsroom/notice-proposed-rulemaking-air-carrier-definitions
37 https://www.federalregister.gov/documents/2022/11/08/2022-23962/airworthiness-criteria-special-class-airworthiness-criteria-for-the-joby-aero-inc-model-jas4-1
38 https://aviationweek.com/aerospace/advanced-air-mobility/faa-takes-step-toward-evtol-operating-rules

7. Glossary

Term	Definition
AAM	Advanced air mobility
ACP	Airspace Change Process, as defined currently by CAP 1616, which is available on the CAA website: https://publicapps.caa.co.uk/cap1616
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
CAA	Civil Aviation Authority (the UK aviation authority)
CAP	All CAA publication titles include a CAP number
DfT	Department for Transport
EASA	European Aviation Safety Agency
eVTOL	Electric vertical take-off and landing
FAA	Federal Aviation Administration (the US aviation authority)
FAIWG:AI	Future Flight Integration Working Group on Airspace Integration
FIS-B	Flight Information Service - Broadcast
ICAO	International Civil Aviation Organization
MVP	Minimal Viable Proposition
NPA	Notice of Proposed Amendment (used by aviation authorities such as EASA and FAA to give notice of intention to change regulations)
ORS	Official Record Series - this is a category of publications by the CAA[39]
RPAS	Remotely Piloted Aircraft System (more commonly referred to as a drone)
PDRA	Pre-defined Risk Assessment[40]

39 CAA ORS can be found on their website: http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=list&type=sercat&id=17

40 For further information on UK UAS PDRAs see CAP722H on the CAA website: https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=11731

Term	Definition
SFAR	Special Federal Aviation Regulation - a temporary FAA rule with an expiry date to address a temporary situation
SMS	Safety Management System[41]
SORA	Specific Operations Risk Assessment (The SORA is a methodology for the classification of the risk posed by a drone flight in the specific category of operations and for the identification of mitigations and of the safety objectives (source: EASA))
SWIM	System Wide Information Management System
TDA	Temporary Danger Area (temporary airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times)
TMZ	Transponder Mandatory Zone (note the requirement for equipage can be met with various surveillance solutions, a transponder itself may not specifically be required)
UAS	Uncrewed Aircraft System, this includes remotely piloted and autonomous aircraft systems
UTM	UAS Traffic Management
UKRI	UK Research and Innovation

41 For further information from CAA on SMS: https://www.caa.co.uk/safety-initiatives-and-resources/working-with-industry/safety-management-systems/safety-management-systems/