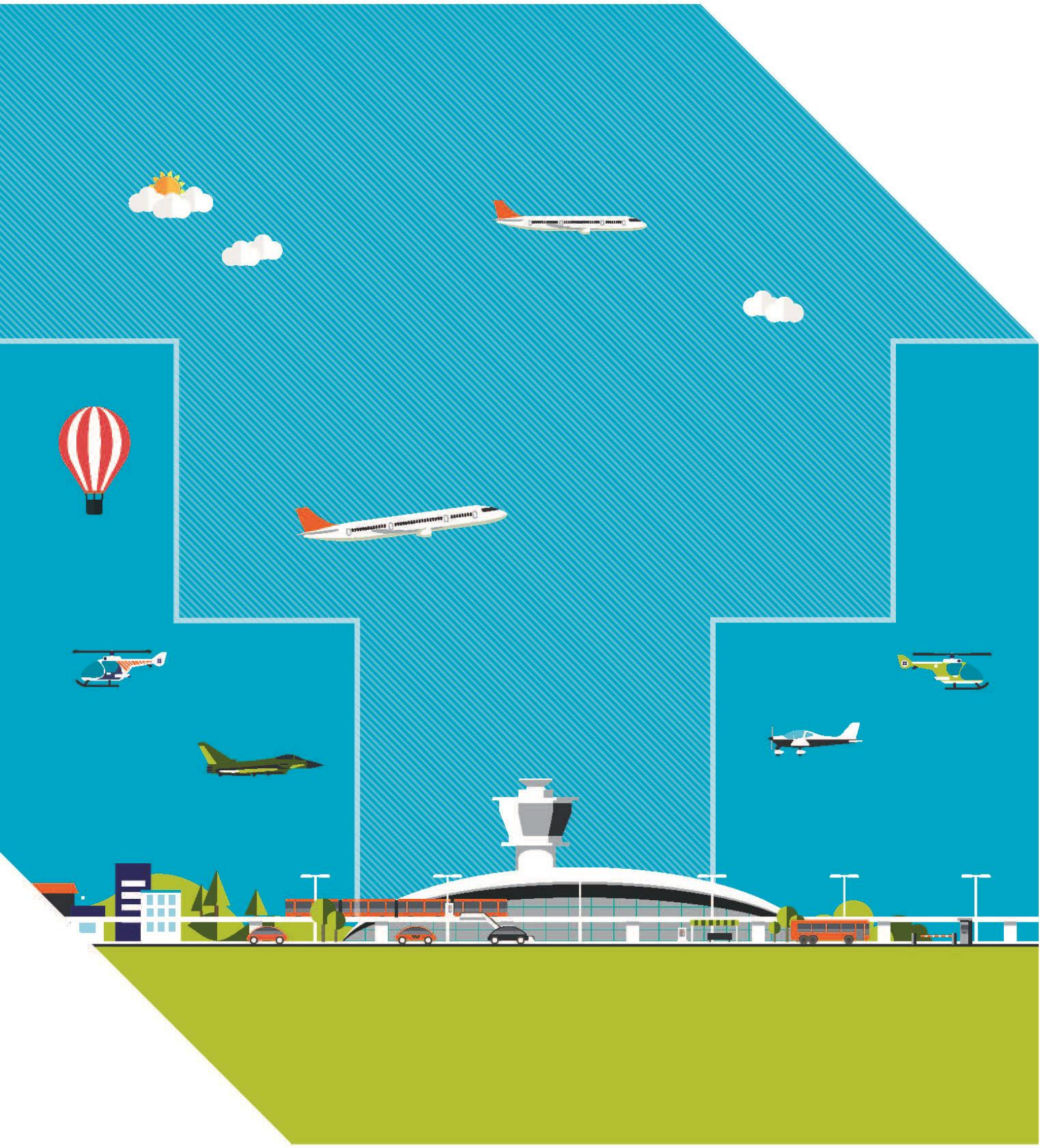
Draft Airspace Modernisation Strategy 2022–2040
Part 1: Strategic objectives and enablers

CAP 2298a



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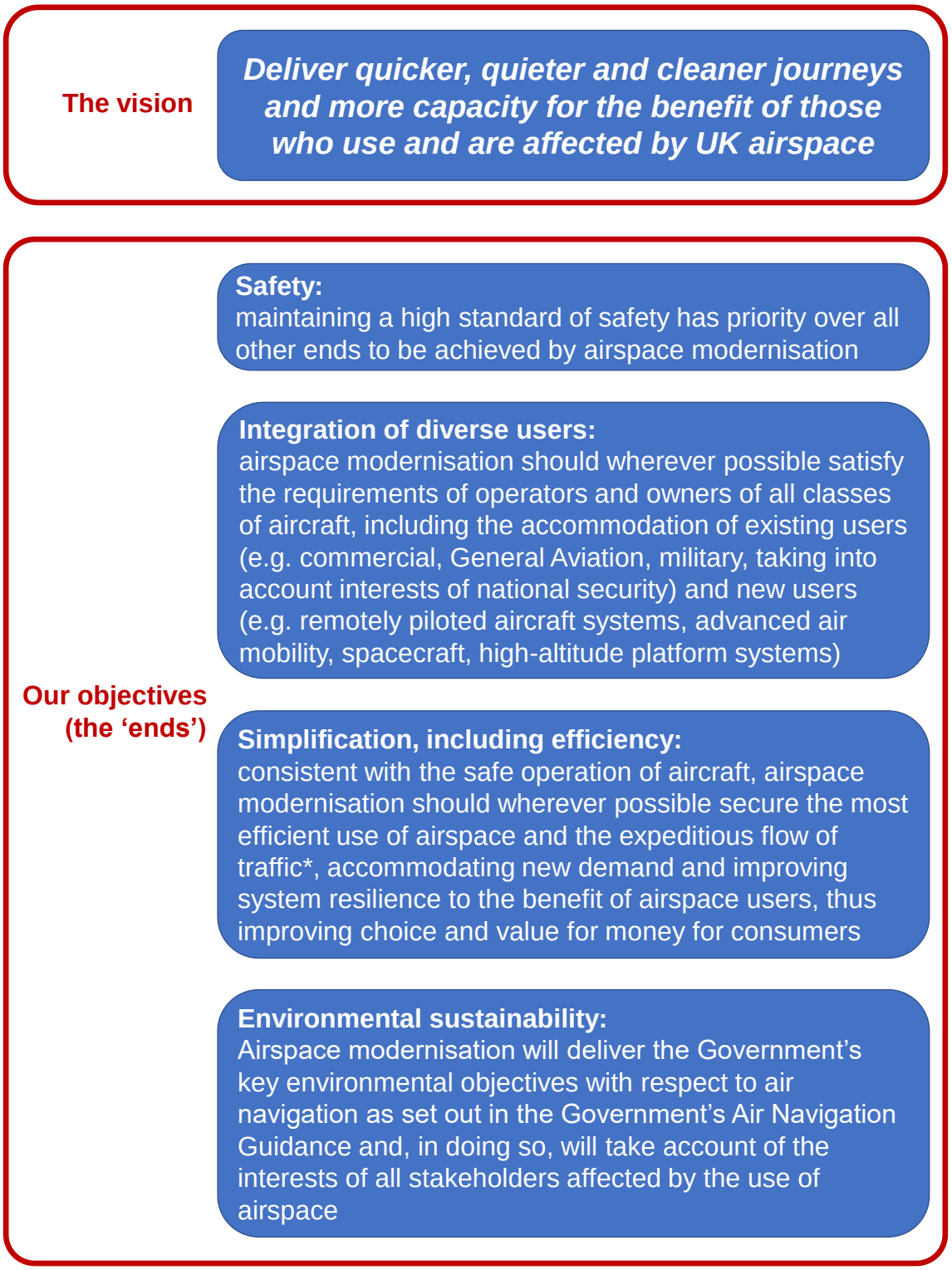
Contents

Contents 3
The strategic vision for airspace modernisation to 2040 5
Chapter 1 Overview 6
Background to the Airspace Modernisation Strategy 6
The shared vision and objectives for modernising airspace 7
Structure of the AMS – ends, ways and means for modernising airspace 9
Reviewing and updating the strategy 14
Chapter 2 Ends: strategic objectives, drivers and benefits of airspace modernisation 15
Introduction 15
A: Strategic objectives for modernisation 16
B: Drivers for change 30
C: The benefits and impacts of airspace modernisation 35
Chapter 3 Key ways of modernising airspace through ICAO GANP 39
Introduction 39
ICAO Global Air Navigation Plan (GANP) 39
Key ways of modernising airspace 42
Evolutionary steps, aligned with the ASBU steps 42
Information 45
Operational 46
Technology – integrated Communications, Navigation, Surveillance and Spectrum approach 47
Transformation 54
Chapter 4 Overview of AMS delivery elements 56
Chapter 5 Use cases – a vision of airspace in the 2030s 63
Use case 1: The future structure of airspace 65
Use case 2: Air Traffic Service provision 69
Use case 3: Remotely piloted aircraft systems 70
Use case 4: Spacecraft (ground- or air-launched) 71
Use case 5: Recreational General Aviation flight between two small airfields in class G airspace 72

Chapter 6 Funding 74
Overview 74
AMS Support Fund 74
Financing other aspects of modernisation 75
Future funding models 76
Appendix A Legal and policy framework 77
Overview 77
The Civil Aviation Authority (Air Navigation) Directions 2017 78
Transport Act 2000 79
Air Navigation Guidance 2017 80
Jet Zero strategy 81
Airport capacity 82
ICAO and Europe 84
Procedure for the CAA to review the classification of airspace 86
Summary of developments 87
Appendix B Glossary 90

The strategic vision for airspace modernisation to 2040



* 'most efficient use of airspace' and 'expeditious flow' are defined at the foot of page 22.

Figure 1: Strategic vision and objectives for modernising airspace

Chapter 1

Overview

Background to the Airspace Modernisation Strategy

1.1 Under the Civil Aviation Authority (Air Navigation Directions) 2017, as amended (the Air Navigation Directions), the Secretary of State has given the CAA the function to prepare and maintain a **co-ordinated strategy and plan for the use of all UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace**.[1] This is consistent with the CAA's role as specialist aviation regulator and its statutory responsibilities. In line with these duties, in December 2018, we published the **Airspace Modernisation Strategy** (AMS), initially focusing on the period to 2024, replacing our earlier Future Airspace Strategy.

1.2 In this document we have refreshed the 2018 AMS:

- to extend the strategy's focus from 2024 out to 2040, as required by the Air Navigation Directions (the need for which we recognised in the 2018 strategy)
- to take account of the latest developments in innovation and technology, placing integration of all airspace users at the core of the strategy, including accommodating new types of aerial craft like drones[2], advanced air mobility (aerial taxis) and spacecraft
- to aim for simpler airspace design and supporting regulations
- to introduce sustainability as an overarching principle to be applied through all modernisation activities, taking account of the latest government policy and environmental guidance, including better managing noise and helping achieve government commitments to net zero emissions

1 Direction 3(e). The Directions were amended in 2018 and 2019. A consolidated version is on the CAA website https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Legislative-framework-to-airspace-change/

2 Remotely piloted aircraft systems (RPAS) may be referred to as unmanned aerial vehicles (UAV), uncrewed aircraft, drones, model aircraft or radio-controlled aircraft. For more information see https://www.caa.co.uk/Consumers/Unmanned-aircraft/Our-role/An-introduction-to-unmanned-aircraft-systems/.

- to meet the UK's international obligations, aligning delivery of the AMS with the ICAO[3] Global Air Navigation Plan (GANP) and ensuring interoperability of the UK network with neighbouring air traffic management areas, including providing a clear strategic path for rulemaking activities, now that the UK has left the EU and the European Aviation Safety Agency

all without undermining the initiatives from the 2018 AMS, delivery of which will continue, and which are subsumed into the refreshed AMS.

1.3 The refreshed strategy therefore pulls together the ICAO GANP, the 2018 AMS initiatives and also new requirements that the CAA has identified through extensive stakeholder engagement in 2021–2022.[4]

1.4 As required by the Air Navigation Directions, the CAA must consult the Secretary of State about the preparation and maintenance of this strategy and the detail to be included in the delivery and deployment plans (which form Parts 2 and 3 of this strategy). The CAA also reports to the Secretary of State annually on the delivery of the strategy.[5]

1.5 We will continue to review and update the AMS in the light of ongoing developments, to measure progress against the delivery plans and in order to continue providing annual delivery reports to the Secretary of State. Where appropriate, we may seek stakeholder comments on these updates before implementing them, but we will not necessarily do so in every case.

The shared vision and objectives for modernising airspace

1.6 The Department for Transport and CAA are co-sponsors for airspace modernisation, and are working together to deliver our shared **strategic vision and objectives for the modernisation of UK airspace** (Figure 1 above).

1.7 There are two distinct roles within this co-sponsor arrangement:

- the **Department for Transport** will develop and own national policy, including the strategic case for airspace modernisation and the objectives

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3 The International Civil Aviation Organization, a specialist agency of the United Nations responsible for international standards for civil aviation which the UK is bound by international treaty to implement. ICAO's strategic objectives (in respect of global aviation, not just airspace) can be read here https://www.icao.int/about-icao/Council/Pages/Strategic-Objectives.aspx.

4 This engagement, which included numerous listening, feedback, requirements-gathering, co-creation and review group sessions, is described in CAP 2281 Airspace Modernisation – 2021 Progress Report www.caa.co.uk/cap2281.

5 These progress reports can be seen at www.caa.co.uk/cap1862 (2019), www.caa.co.uk/cap2016 (2020) and www.caa.co.uk/cap2281 (2021).

it must deliver; the Secretary of State also sets the CAA's role in the Air Navigation Directions

- the **CAA**, as independent regulator as well as technical adviser to government, will develop and maintain an AMS and oversee and report annually to the Secretary of State on its delivery, consistent with our duties under section 70 of the Transport Act 2000 and the policy framework set by government, including the UK's international obligations. The CAA's focus is on the technical policy framework required to enable the changes and to identify and propose new rulemaking activities. The CAA also ensures adherence to the CAP 1616 airspace change process.

1.8 The AMS shared strategic vision and objectives are therefore informed by government policy and the CAA's statutory duties. They also remain aligned with the strategic objectives of ICAO.

Delivering airspace modernisation

1.9 Although the Department for Transport and the CAA have developed the shared strategic vision and objectives for airspace modernisation, we cannot deliver these alone. Airspace modernisation will need to be delivered collaboratively by a range of aviation organisations, such as air navigation service providers, airports, airlines, manufacturers, representative organisations and, where appropriate, bespoke delivery bodies. A wider range of other stakeholders will need to be engaged throughout this delivery. The co-sponsors may commission specific projects necessary for airspace modernisation – for example the airspace change masterplan that ACOG (the Airspace Change Organising Group) is developing[6] – agreeing what must be delivered and the outcomes. We may also set parameters for delivery groups tasked with planning and delivering modernisation projects. The Department for Transport and the CAA are committed to working with relevant stakeholders and those tasked with delivery to ensure modernisation happens in a coherent and consistent way, delivering the benefits set out in the shared strategic vision and objectives. As explained below, in refreshing the AMS, the detail of delivery and deployment are being published separately from the overall strategy set out in this document.

1.10 The AMS will guide the delivery of relevant and timely policy and regulation across the whole CAA that supports the delivery of airspace modernisation

[6] For more information about the masterplan – a single coordinated implementation plan for airspace changes in the UK to cover the period to 2040 – please see https://www.acog.aero/airspace-masterplan/ and https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/Airspace-Modernisation-Update/. New CAA webpages for the AMS and masterplan are in the process of being created.

goals. In particular, it will be used to assist in the prioritisation of UK airspace rulemaking activity to help ensure its timely and coordinated implementation.

Structure of the AMS – ends, ways and means for modernising airspace

1.11 The AMS sets out the **ends**, **ways** and **means** of modernising airspace:

- the **ends** are the policy objectives for achieving the shared strategic vision for airspace modernisation
- having explained those ends, the strategy describes the **ways** of achieving them (the enablers) – such as new airspace design, new operational concepts and implementable new technologies
- to establish the **means** of delivering modernised airspace, such as the resources needed, this strategy requires organised project teams, led by industry and other entities, to draw up delivery plans, with delivery overseen by the CAA.

Content of each part of the strategy

1.12 The AMS 2022–2040 is split into three parts plus an annex (Figure 1.1 below). **Part 1 (Strategy)** – this document – explains the strategy's objectives (the **ends**) and a high-level overview of what will enable those objectives to be fulfilled (the enablers or **ways**).

1.13 **Parts 2 and 3 (Delivery)**[7] explain how the strategy is being delivered. These are published separately that describe the short-term ambition. Part 2 explains the different elements that make up delivery (the **ways,** in more detail). Part 3 sets out progress with deployment and related activities for those elements (the **means**). Parts 2 and 3 are likely to be updated more frequently than Part 1 as the elements evolve and mature for delivery. The intent is for stakeholders to be able to readily identify the modernisation elements that are most relevant to them and which will help to deliver their ambitions.

1.14 Part 1 does not specify detailed solutions, allowing space for innovation. The means of delivering some of the ends required for airspace modernisation are still being developed in detail – for example, the approach to integrating operations of new types of airspace user.

[7] Like Part 1, the document you are reading, Part 2 of the AMS is currently only in draft form, for the purposes of consultation, which can be viewed at https://consultations.caa.co.uk/policy-development/draft-airspace-modernisation-strategy-2022-2040. Final versions will be published later in 2022. The plans in Part 3 are not being published at this stage until we have consulted on drafts of Parts 1 and 2 of the AMS.

1.15 As with the 2018 strategy, there is a separate AMS governance annex, published by the Department for Transport and CAA jointly, as co-sponsors of airspace modernisation.

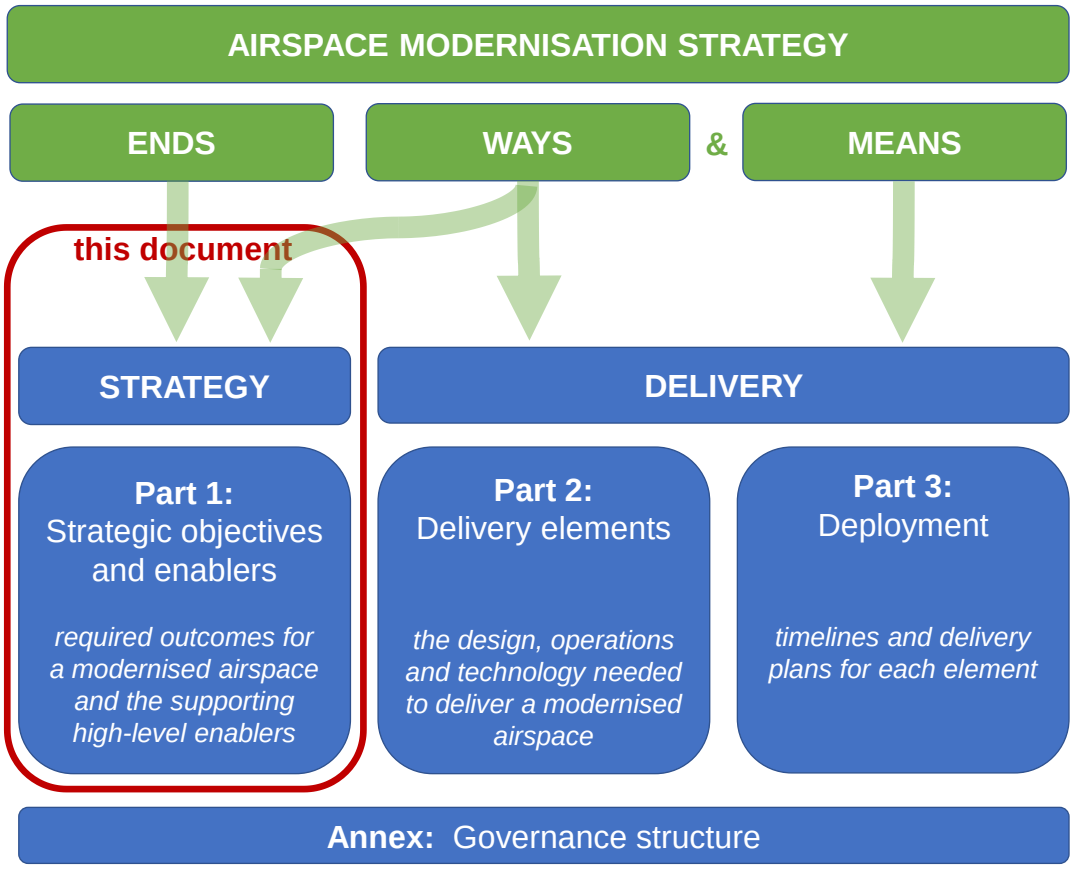


Figure 1.1 Structure of the AMS

Part 1: Strategic objectives and enablers

1.16 Part 1 comprises:

- the overall vision for airspace modernisation
- **Chapter 1:** Overview of the AMS
- **Chapter 2:** The 'ends' that airspace modernisation must deliver:
  - the **strategic objectives** to achieve that vision, grouped under four headings: safety, integration, simplification and sustainability
  - the **drivers** for airspace modernisation, grouped under four headings: meeting airspace demand sustainably, innovation, international obligations and defence
  - the **benefits** of airspace modernisation, by stakeholder group.

- **Chapter 3:** The key 'ways' of modernising airspace, aligned with the ICAO Global Air Navigation Plan: information, operational and technology
- **Chapter 4:** Overview of AMS delivery initiatives
- **Chapter 5:** Use cases – a vision of airspace in the 2030s
- **Chapter 6:** Funding
- **Appendix A:** The legal and policy framework with which the AMS must comply.
- **Appendix B:** Glossary of terms.

Part 2: Delivery elements

1.17 Part 1 explains the longer-term vision. Part 2 is more focused on the near term, and will evolve over time, aligned with the ICAO GANP programme. GANP uses a guiding deployment framework known as the Airspace System Block Upgrade (ASBU) with workstreams organised into 'threads' and 'elements' (see Chapter 3). Part 2 expands on the ASBU threads to provide the essential detail of the development activities – known as delivery elements – making up the strategy. While the ASBU threads have extensive operational and technical descriptions, not everything will be wholly applicable to the UK, while some activities necessary for modernisation of UK airspace will be specific to the UK.

1.18 The delivery elements in Part 2 are therefore based on ICAO operational and technical descriptions but tailored to the needs of UK airspace. They form the basis of research and development activities over the near term in support of deployment, including how those activities are funded. Part 2 also identifies legislative, policy or regulatory gaps that need to be addressed, for example how to accommodate new types of aircraft in UK airspace like drones or spacecraft, or trade-offs between increased capacity, carbon emissions, noise, or other factors.

Part 3: Deployment

1.19 Part 3 of the AMS[8] sets out the constituent industry (and other entity) deployment plans and activities including research activities in support of deployment. As noted above, the UK delivery elements will use the ASBU deployment framework, aligned with the ASBU threads.

1.20 These activities are subject to the oversight of the CAA's airspace modernisation oversight team. The output informs the CAA's annual progress report to the Secretary of State on the AMS, as well as the UK's progress reports to

[8] As explained at the foot of page 9, the plans in Part 3 are not being published at this stage and will be developed in due course.

EUROCONTROL through the Local Single Sky implementation monitoring (LSSIP).[9]

AMS governance annex

1.21 Key to delivering airspace modernisation successfully is that each of the entities involved has the right role, powers and/or incentives, underpinned by appropriate governance and enforcement.

1.22 There are two distinct strands to governance of the strategy:

- ongoing review of the strategic content
- oversight activities reporting progress on delivery through the CAA airspace modernisation oversight team.

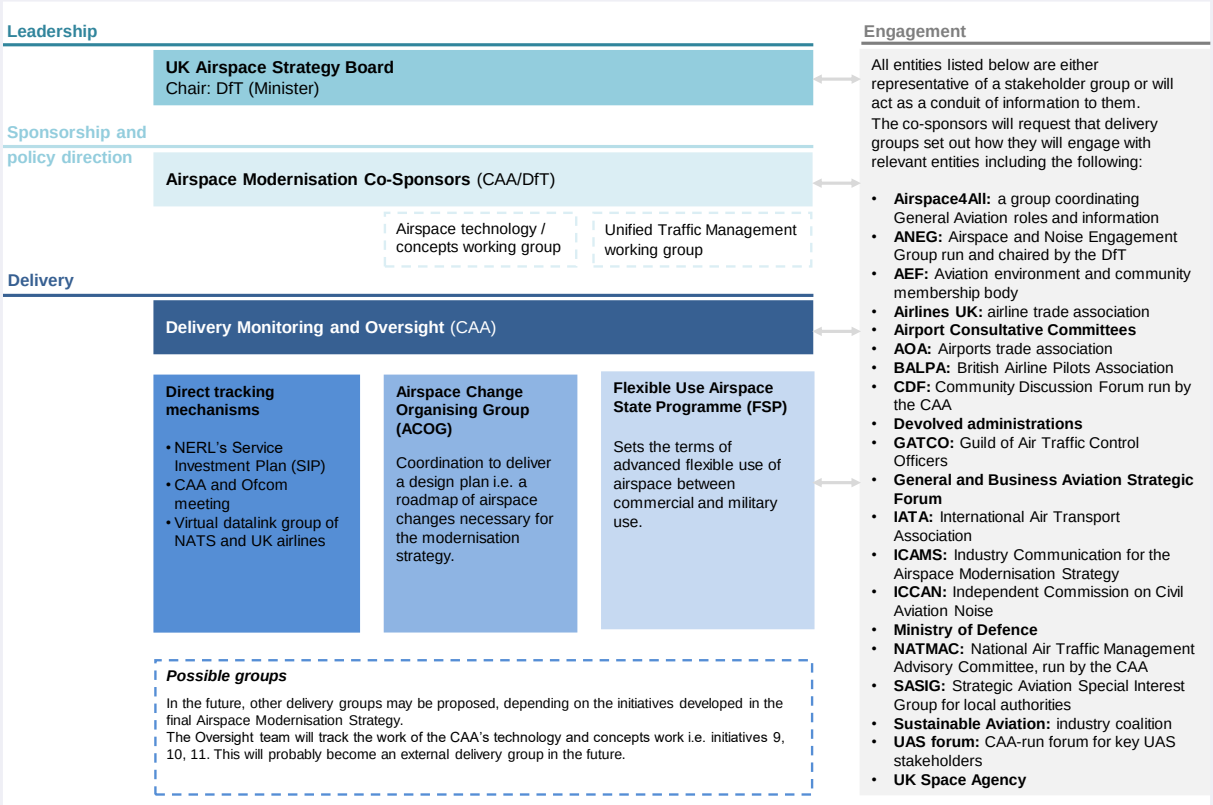
[9] For example, UK LSSIP 2020 https://www.eurocontrol.int/sites/default/files/2021-03/eurocontrol-lssip-2020-uk-level1_0.pdf. LSSIP documents provide an annual view of how 41 member states of EUROCONTROL (plus Israel and Morocco) and relevant stakeholders are progressing in planning and deploying the mature elements of the European ATM Master Plan. https://www.eurocontrol.int/service/local-single-sky-implementation-monitoring

Placeholder:

The 2018 AMS governance structure was developed by the Department for Transport and CAA working with NERL (NATS (En Route) plc) and the Infrastructure and Projects Authority. It formed an annex to the 2018 AMS but is now out of date. It reflects the legal framework including the Air Navigation Directions, and sets out which organisations make decisions and have accountabilities, and the stakeholders they will engage and consult with as they carry out their strategic roles.

Figure 1.2 shows the structure we last published in CAP 1862 in December 2019, which itself updated the original 2018 CAA/Department for Transport AMS governance annex CAP 1711b. Further changes have occurred in the last two years.

The CAA is now consulting on the AMS governance structure and will take respondents' views into account when considering with the Department for Transport whether changes should be made. For more information, including how to give us your views, please refer to the CAA's consultation website https://consultations.caa.co.uk/policy-development/draft-airspace-modernisation-strategy-2022-2040.



Note: CAP 1711b AMS Governance Annex provides further detail about the groups shown.

Figure 1.2 Governance structure for the AMS (as at December 2019)

Reviewing and updating the strategy

1.23 Any nationally strategic infrastructure must respond to its immediate context – a context that is often continually developing and changing. Airspace is no exception. The political, economic, social, technological and environmental drivers within which airspace modernisation must happen will never sit still. There are innovations and disruptions that continually shift.

1.24 The CAA will develop or implement a solution or enabler to better respond to a change or gap where it is within our remit and appropriate for us to do so. This will often require working with others, such as the Government, which is responsible for all relevant UK policy and law. We have set out in the strategy where these foreseeable 'unknowns' exist that could change and reshape the context. There will also be 'unknowns' that are not foreseeable, and which, by definition, cannot presently be considered in this strategy. For example, this may include developments in neighbouring air traffic management areas, especially our European neighbours, given the need to manage traffic effectively end to end.

1.25 Bearing in mind the 2040 timescale specified by the Government, the CAA will therefore continue to keep the context for the AMS under review and update it where necessary. This particularly applies to Parts 2 and 3 containing the delivery elements, as technological innovations are forthcoming or become ubiquitous, gaps in the policy or regulatory framework emerge that are affecting delivery, or where the Government has signalled upcoming or widescale policy developments (Net Zero being a good example). We will monitor developments, including through our oversight function and our annual AMS progress reports to the Secretary of State, collating aspects that need amendment. The pace of change may mean that for practical reasons we review and update the AMS in stages. In other words, some developments may move on before the CAA is able to review and update the relevant part of the strategy.

1.26 Where appropriate, the CAA may seek comments on these updates before implementing them, but we will not necessarily do so in every case.

Chapter 2

Ends: strategic objectives, drivers and benefits of airspace modernisation

Chapter summary

This chapter considers the strategic objectives, drivers and benefits of airspace modernisation, notably:

- A: Strategic objectives:
  - Maintaining and enhancing high aviation safety standards
  - Integration of diverse users – including needs of defence and security
  - Simplification – reduce complexity and improve efficiency
  - Environmental sustainability – improving aviation's environmental impacts
- B: Drivers for change: a reminder of why UK airspace is in need of modernisation
  - Meeting the demand for airspace, more sustainably
  - Encouraging aviation innovation to support UK economic growth
  - International obligations
  - Facilitating defence and security objectives
- C: The benefits and impacts of airspace modernisation
  - UK economy
  - Passengers and shippers
  - Climate change impacts
  - Communities impacted by aircraft noise
  - Aircraft operators
  - Airport operators
  - Air navigation service providers
  - Government

Introduction

2.1 This chapter considers the '**ends'** to be achieved from airspace modernisation, and the background. Ultimately the ends, and the **ways** those ends are delivered, are driven or shaped by the UK legal and policy framework, and by our statutory duties and international obligations to ICAO. Section 70 of the Transport Act 2000 sets out how the CAA should exercise its air navigation functions including those related to airspace and the use of airspace, however, other legislation and government policy may also be relevant when the CAA

discharges its functions in this area, as described in more detail in Appendix A. For example, the UK's climate change obligations in the Net Zero strategy, transition to a route structure designed using performance-based navigation[10] as recognised in the Government's Air Navigation Guidance to the CAA, and the Government's Airports National Policy Statement regarding additional runway capacity in the South East.

2.2 We have arranged this chapter under three headings:

A: the strategic objectives for modernisation

B: drivers for change: a reminder of why modernisation is essential

C: benefits and other impacts of modernisation.

A: Strategic objectives for modernisation

2.3 The strategic case for airspace modernisation and the resultant benefits were set out by the Department for Transport in 2017.[11] The aviation industry has already started a major investment programme to upgrade the UK's airspace structure because it was outdated, inefficient, and reaching its capacity. As noted in Chapter 1, the roadmap to modernisation was set by the CAA's first AMS, published in December 2018, replacing our earlier Future Airspace Strategy.

2.4 The co-sponsors' vision and strategic objectives for airspace modernisation are summarised at the beginning of this strategy document, on page 5. Below we explain some of the background to these objectives under four overarching headings: **safety**, **integration**, **simplification**, and **sustainability**.

2.5 The operational challenges that we set out are not specific to the UK. This makes international alignment and cooperation vital, so we can learn from each other and help foster solutions that benefit the industry while helping to reduce any adverse impacts. The global vision and leadership embodied in the ICAO

[10] Performance-based navigation is a concept developed by ICAO that moves aviation away from the traditional use of aircraft navigating by ground-based beacons to a system more reliant on airborne technologies, utilising area navigation and global navigation satellite systems. Its use enhances navigational accuracy. For more information, see Annex B of the Air Navigation Guidance 2017 https://www.gov.uk/government/publications/uk-air-navigation-guidance-2017 and https://www.caa.co.uk/Commercial-industry/Airspace/Communication-navigation-and-surveillance/Performance-based-navigation/.

[11] For more information see *Upgrading UK airspace, strategic rationale*, Department for Transport, 2017. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/586871/upgrading-uk-airspace-strategic-rationale.pdf

GANP outline an evolution in the air navigation system for all States and stakeholders.[12]

Safety

Maintaining a high standard of safety has priority over all other 'ends' to be achieved by airspace modernisation

2.6 Maintaining a high standard of safety has priority over all other ends to be achieved by airspace modernisation. This is a statutory duty for the CAA under section 70(1) of the Transport Act.

2.7 The UK's airspace has an excellent safety record that is underpinned by a well-established system of structures, rules and procedures. As this system has matured and demand from users grows, there are areas highlighted though our comprehensive safety reporting mechanisms that require improvement. The potential to deliver further safety improvements has, however, become limited.

2.8 However, the pace of change across the aviation industry is set to quicken as traffic levels recover post-pandemic across the commercial air transport, General Aviation[13] and military sectors, at the same time as demand from innovative new airspace users, such as remotely piloted aircraft systems[14], continues to develop rapidly. **There is a requirement for airspace modernisation to enable aviation innovation while at the same time maintaining high standards of aviation safety**.[15] This includes reducing the complexity of airspace structures (see below) and introducing new technologies that help to manage any residual operational risk. We say more about these different benefits below. The goal of the Government's State Safety Programme is that the UK's aviation safety performance remains among the best in the world.[16]

2.9 ICAO's safety strategy[17] supports the prioritisation and continuous improvement of aviation safety. It has an aspirational safety goal of zero fatalities in

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12 ICAO's stated purpose for the GANP is to equitably accommodate all airspace users' operations in a safe, secure and cost-effective manner, while reducing the aviation environmental impact.

13 Essentially all civil flying other than commercial airline operations, which therefore encompasses a wide range of aviation activity from paragliders, microlights, gliders and balloons to corporate business jets and aerial survey aircraft, and includes all sport and leisure flying. https://www4.icao.int/ganpportal/document/inputGA

14 Accepting that the model aircraft community are not new airspace users.

15 See, for example, the co-sponsors' continuing commitment to modernisation despite the impacts of the pandemic. https://www.gov.uk/government/publications/update-on-airspace-modernisation/dft-and-caa-update-on-airspace-modernisation-march-2021

16 *State Safety Programme for the United Kingdom*. https://www.caa.co.uk/Safety-initiatives-and-resources/How-we-regulate/UK-State-Safety-Programme/

17 *Global Aviation Safety Plan*, ICAO. https://www.icao.int/safety/GASP

commercial operations by 2030 and beyond, and to reduce the risk of fatalities associated with accidents.

Integration of diverse users

Airspace modernisation should wherever possible satisfy the requirements of operators and owners of all classes of aircraft, including the accommodation of existing users (e.g. commercial air transport, all General Aviation operations, military, taking into account interests of national security) and new users (e.g. remotely piloted aircraft systems, advanced air mobility (aerial taxis), spacecraft, high-altitude platform systems)

Current UK airspace structure

2.10 UK airspace is an essential, but largely invisible, part of our national transport infrastructure. It is a shared and (in certain regions) scarce resource. The current segregation[18] applied in UK airspace to meet the needs of users is primarily there for safety reasons. The structure specifies the routes that aircraft fly and the procedures and systems used by air traffic controllers to manage traffic flows.

2.11 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.[19]

2.12 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 en route[20] and some terminal approach airspace[21]; airport operators and localised air traffic services providers; and the Ministry of Defence.

2.13 The majority of commercial air transport flights operate in controlled airspace. General Aviation operates largely, but not exclusively, in uncontrolled airspace

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18 Where we use the term “segregation” we mean in the plain English sense (separation), rather than e.g. the ICAO definition where segregated airspace is reserved exclusively for a specific user.

19 See https://www.caa.co.uk/Consumers/Guide-to-aviation/Airspace/How-is-UK-airspace-structured-/ and https://www.nats.aero/ae-home/introduction-to-airspace/.

20 En route means that part of the flight from the end of the take-off and initial climb phase to the commencement of the approach and landing phase.

21 NERL is subject to economic regulation by the CAA. See https://www.caa.co.uk/Commercial-industry/Airspace/Air-traffic-control/Air-navigation-services/NATS-En-Route-plc-NERL-Licence/

below 6,000 feet, alongside a few commercial air transport flights. 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.[22]

2.14 To assure the safety of commercial air transport flights, segregation in the form of controlled airspace is currently used. This segregation may impinge on the availability of airspace for other users. An appropriate balance is needed to satisfy both the safety and economic requirements of the various types of (at times, conflicting) user operational requirements. At lower altitudes there is more of a challenge in balancing the differing requirements of a wider range of affected parties.

Future integration of air traffic

2.15 The forecast recovery and growth in traffic and continuing technological advancements (see 'B: Drivers for change' below) will require access to, and management within, the finite volume of UK airspace. To facilitate access by diverse airspace users, **there must be a transition towards greater integration of air traffic, where it is safe to do so**. Achieving this will require a consideration of new airspace designs, operating procedures, technologies and equipment.

2.16 An area of concern within uncontrolled airspace is the risk of mid-air collision where military, General Aviation and some commercial air transport aircraft are operating in an environment where the overarching operating principle is 'see and avoid', at times with limited supporting air traffic services and surveillance coverage. Each has responsibility for maintaining its own visibility to others and keeping a lookout for aircraft in order to avoid them. This can be of particular concern around smaller aerodromes that have no surveillance capability themselves and in areas with a high density of airspace users that may be harder to see with the naked eye, such as light aircraft, gliders, hang-gliders and drones.

[22] Military requirements vary widely from, among other things, electronic warfare training to air-to-ground ranges or access for remotely piloted air systems (drones).

2.17 Modernisation of air traffic management and airspace will use technology to manage airspace in a flexible, near real-time operation, from high-altitude airspace to very low urban airspace environments.

2.18 **A vital aid to better sharing and access among different users of airspace is full electronic conspicuity of UK airspace users** between each other and with air traffic management service providers, to ensure that this integrated air operation is safe. Electronic conspicuity allows airspace users to detect all others and be detected by all others. Airspace users will include crewed operations as well as remotely piloted and advanced air mobility operations.[23]

Electronic conspicuity is an umbrella term for the technology that can help pilots, remotely piloted aircraft systems and air traffic service providers be more aware of what is operating in surrounding airspace. Electronic conspicuity includes the devices fitted to aircraft that send out the information, and the supporting infrastructure to help them work together. Airborne transponders, air traffic data displays, ground-based antennas and satellite surveillance services are all examples of electronic conspicuity. The information generated by these can be presented to pilots and air traffic services visually, audibly or both to provide them with information on other traffic nearby. This strengthens the principle of 'see and avoid' by adding the ability to 'detect and be detected'. To be most effective it needs 100% of users operating in a designated block of airspace to be using compatible electronic conspicuity devices, and to be able to be detected by others.

2.19 Air and ground systems, including airports, will act as a single integrated infrastructure to accommodate the growth of air traffic and a better performing aviation system supporting development of an intermodal environment. Remotely piloted or unpiloted aircraft will expand traditional business models and accelerate the transition towards an environment that is rich in digital information. At the core of this transformation is a strong need for a fully harmonised global air navigation system built on agreed performance-based standards with interoperable and scalable systems.

2.20 New entrants, including remotely piloted or unpiloted aircraft, operating at the lowest and highest altitudes, will have different expectations of the services needed to support their operations, but require access to and to be integrated into the UK airspace operation. Existing infrastructure and services will evolve to serve new entrants with the aim of UK airspace being as available and easy to access as possible. In order to accommodate the growing demand for access to the airspace by such operations, a system for managing cooperative deconfliction based on a model of shared information needs to be adopted on a wider scale.

[23] For more information on innovative air vehicles and their integration into UK airspace see CAP 2122 *Advanced Air Mobility: Taking a Use Case Approach* www.caa.co.uk/cap2122 and CAP 1868 *A unified approach to the Introduction of UAS Traffic Management* www.caa.co.uk/cap1868.

2.21 This information-rich environment encourages collaborative decision-making in a network-centric context to enable management by trajectory (see Chapter 3), which will improve mission- and business-oriented operations. Information also plays an integral role in the highly interconnected systems that will increasingly enable autonomous operations and human-machine collaboration.

2.22 There will be an ongoing requirement to provide areas of restriction in the airspace for safety reasons when activities such as military or emergency services operations and training or space launches are undertaken. Interoperability of airborne and ground systems will help enable more flexible designs of airspace, encouraging integration rather than segregation, whereby airspace is considered as a shared resource and is allocated for specific periods of time to particular users. For example, the Flexible Use of Airspace concept where the military reserves airspace temporarily and releases it for civil use when it is not required.

2.23 Commercial space and larger remotely piloted operators requiring access to airspace will also gain that access through a reservation system, with separation managed in the same way as conventional piloted aircraft. The airspace requirement for spacecraft and launch activities will be large in order to provide suitable protection for the operation. This is likely to place restrictions on other airspace users, albeit infrequently and for relatively short periods of time. Compared with launch sites in other countries, the UK's limited airspace will require definition of spaceflight capabilities as well as the initiation and cessation of airspace reservations.

2.24 Ideally, the air navigation system should avoid to the greatest extent possible imposing restrictions on individual flight operations. In practice, this is rarely feasible because of external constraints or the conflicting needs of airspace users, among other reasons. In such cases, the overall ambition is to seek an optimum combination of trade-offs that maximises the collective performance of all members (i.e. network optimisation), while upholding predefined requirements for safety, security, the environment, access and equity. This will be achieved through collaborative decision-making involving all members on multiple planning horizons.

2.25 The overall goal is to continuously seek optimum network performance under a variety of operational conditions. The aim is to progressively reduce the impact of trade-offs and, essentially, enable airspace users to fly their preferred trajectories. The air navigation system should therefore be flexible enough to integrate changes in business and operational trajectories at the frequency required by airspace users.

Simplification – reduce complexity and improve efficiency

Consistent with the safe operation of aircraft, airspace modernisation should wherever possible secure the most efficient use of airspace and the expeditious flow of traffic[24], accommodating new demand and improving system resilience to the benefit of airspace users, thus improving choice and value for money for consumers

Reducing complexity

2.26 UK airspace is among the most complex in the world, yet its underpinning design dates back to the 1950s. In recent years, successfully accommodating the growth in demand for air transport has meant adding significant complexity to the UK's airspace system, particularly where traffic volumes are highest, principally over South-East England. Aircraft performance and navigation capabilities have changed significantly. To fully utilise the performance capabilities of modern aircraft, aviation needs an efficient and effective airspace structure.

2.27 As described in Chapter 1, an iterative approach to development of the airspace structure has created several issues that limit the sector's ability to continue to add airspace capacity without making some more fundamental changes. For example, upper airspace was structured around a fixed network of waypoints that are based on the position of ground navigation beacons, which modern aircraft no longer require. The fixed number of established routes limits capacity in the cruise phase of flight, constraining the flow of traffic.

2.28 Much of the controlled airspace that serves multiple airports (often in close proximity) in the busy lower airspace areas has become a complex web of intersecting flightpaths. Although added to and adapted in response to growing traffic levels, many arrival and departure routes at major airports, for example, have hardly changed for years, even decades. These outdated arrival and departure routes are again based on obsolete ground navigation beacons and restrict the potential improvements in environmental performance.

2.29 By not utilising the modern technologies available, current flightpaths constrain aircraft climb performance, increasing the time taken to reach optimum cruising altitude. This creates inefficiencies and results in more emissions and greater fuel burn.

2.30 A significant redesign is needed to enable the most efficient use of available airspace. Airports' standard arrival and departure routes need to be upgraded

[24] The CAA uses the following overall definition of 'the most efficient use of airspace': *The most aircraft movements through a given volume of airspace over a period of time in order to make the best use of the limited resource of UK airspace from a whole-system perspective*. The CAA uses the following definition of 'expeditious flow': *The shortest amount of time that an aircraft spends from gate to gate, from the perspective of an individual aircraft, rather than the wider air traffic system*.

using performance-based navigation to optimise capacity and introduce the flexibility that, in collaboration with impacted communities, can allow industry to better manage noise impacts.

Securing the efficient use of airspace

2.31 Airspace modernisation can improve the management of airspace as a network by gathering and sharing more accurate flight information. The consequent gains in efficiency create more network capacity allowing the removal of restrictions and better resilience.

2.32 In today's operation, the decisions made by air traffic control to manage the flow of traffic through sectors in line with available capacity are not always based on accurate flight information. Real-time data about when flights plan to arrive in a particular sector, land at an airport, turnaround (reload, refuel etc) and then depart is not always available. The gaps in flight information, and the time and effort needed to close them, reduce the effective capacity of the airspace network and create delays.

2.33 Air traffic controllers manage the interactions between traffic in controlled airspace, providing voice or digital instructions to ensure aircraft are separated. The high workload placed on controllers to manage conflicting traffic itself introduces safety risks that are managed by limiting the flow of traffic when its volume is predicted to exceed a certain level or when disruptive circumstances occur, such as extreme weather conditions. These restrictions regularly create bottlenecks which cause flight delays in the air and congestion on the ground, as aircraft slow down, re-route or wait longer to depart. As traffic grows, new routes that are separated by design (i.e. routes that do not cross) and new technologies that automate controller tasks are needed to maintain high safety standards.

2.34 Airspace modernisation will also strengthen resilience, for both the network and locally at specific airports. The gaps in flight information and lack of spare capacity have weakened the resilience of the airspace network to bad weather and disruption (such as technical problems or unexpected closure of a runway). Unplanned events often lead to significant delays. Normal service is typically only resumed on the next day of operation.

Environmental sustainability

Airspace modernisation will deliver the Government's key environmental objectives with respect to air navigation as set out in the Government's Air Navigation Guidance and, in doing so, will take account of the interests of all stakeholders affected by the use of airspace

2.35 Modernisation will take account of the interests of all stakeholders affected by the use of airspace, in line with government policy and guidance on environmental objectives setting out how greenhouse-gas emissions, air quality

and noise should be considered. The goal is to enhance the sustainability framework to guide the aviation industry in its investment and technological development. As explained above, many air routes and air traffic management practices are not fully utilising the modern technologies available, and aircraft continue to use flightpaths that are outdated.

2.36 In accordance with the Government's key environmental objectives with respect to air navigation as set out in the Government's Air Navigation Guidance (see below), modernisation will minimise the environmental impact of aviation by:

- ensuring that the aviation sector makes a significant and cost-effective contribution towards reducing greenhouse gas emissions
- limiting and, where possible, reducing the number of people in the UK significantly affected by adverse impacts from aircraft noise, and
- minimising local air quality emissions and in particular ensuring that the UK complies with its international obligations on air quality.

Government policy

2.37 In October 2017 the Government issued its revised Air Navigation Guidance to the CAA.[25] The CAA will review the delivery elements in the AMS in 2022 to confirm that they are consistent with the Government's aviation and environmental policies, and if necessary, strengthen requirements or detail as to how the elements should be delivered and with what aims. A key policy issue is how to achieve the benefits of modernised aviation while addressing its environmental impacts, and how to factor those in to the CAA's decision-making[26] on the necessary trade-offs between differing airspace objectives, such as increasing airspace capacity, reducing emissions and managing noise.

2.38 **It is important to recognise that while environmental considerations will form an overarching consideration across the breadth of the delivery workstreams forming a part of the AMS, any airspace redesign must adhere to the policy and guidance framework set by the Government. Environmental impacts often involve trade-off decisions; the policies informing those decisions are a matter for elected representatives, not the CAA or industry**. The CAA anticipates that the owners and operators of

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25 *Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management,* Department for Transport, October 2017 https://www.gov.uk/government/publications/uk-air-navigation-guidance-2017. Section 70(2) of the Transport Act 2000 requires the CAA to take account of any guidance on environmental objectives given to the CAA by the Secretary of State in exercising its air navigation functions. We summarise the legal and policy framework in Appendix A.

26 A proposed change in airspace design must follow the CAA's decision-making process. www.caa.co.uk/cap1616

advanced air mobility and remotely piloted or unpiloted aircraft systems will be subject to the same, or similar, statutory requirements relating to noise as other airspace users.

Jet Zero and sustainable aviation growth

2.39 In April 2021 the Government announced that the sixth carbon budget[27] will for the first time include the UK's share of international aviation and shipping emissions, as recommended by the Climate Change Committee. Such emissions are an important part of the UK's overall decarbonisation efforts. This change allows these emissions to be accounted for consistently with other emissions.

2.40 In July 2021 the Government published its Jet Zero consultation[28] which outlined its vision for the aviation sector to reach net zero – or Jet Zero – by 2050. The Government committed to reaching net zero emissions by 2050 and was consulting on a target for UK domestic aviation to reach net zero by 2040.

2.41 The consultation outlines five core policy measures to achieve net zero aviation, including in-sector reductions through improving system efficiencies, the use of sustainable aviation fuel and zero-emission flight, and the development and implementation of carbon markets and greenhouse gas removal methods to offset residual emissions. The consultation proposes to set a CO_2 emissions reduction trajectory for aviation to 2050 against which progress will be monitored, with the strategy reviewed every five years and the approach updated if needed.

2.42 In October 2021, alongside its Net Zero Strategy[29] the Government published its response to the report of the Climate Change Committee *Progress in Reducing Emissions*.[30] The Committee had recommended that the Government assess its airport capacity strategy in the context of Net Zero and any lasting impacts on demand from COVID-19, as part of the aviation strategy. The Committee had also recommended that there should be no net expansion of UK airport capacity unless the sector was on track to sufficiently outperform its net emissions trajectory and could accommodate the additional demand.

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27 The sixth carbon budget commits the UK in law to the fastest fall in greenhouse gas emissions of any major economy between 1990 and 2035, making it one of the most ambitious climate targets in the world. https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035

28 *Jet Zero consultation: A consultation on our strategy for net zero aviation*, Department for Transport, July 2021. https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050

29 *Net Zero Strategy: Build Back Greener*, HMG, October 2021. https://www.gov.uk/government/publications/net-zero-strategy

30 Climate Change Committee's 2021 progress report: Government response, HMG, October 2021 https://www.gov.uk/government/publications/committee-on-climate-changes-2021-progress-report-government-response

2.43 The Government's response was that flying is a social and economic good, and one that it wholeheartedly supported as a key part of building a global Britain. The Government went on to say that it currently believed that the aviation sector, even if returning to a pre-COVID-19 demand trajectory, could achieve Jet Zero without the Government needing to intervene directly to limit aviation growth. Department for Transport analysis showed that there were scenarios where net zero targets can be achieved by focusing on new fuels and technology, rather than capping demand, with knock-on economic and social benefits. The Government will publish a Jet Zero Strategy in 2022 following a review of consultation responses. The consultation included a question on whether five-yearly reviews should be undertaken on the strategy.

Reducing emissions per flight

2.44 Aircraft often fly further than necessary in the upper airspace on flightpaths that are determined not by the shortest or most cost-effective route to their destination, but by airspace design or by controllers needing to safely separate traffic. Aircraft experiencing delays often have to fly sub-optimal routes, at less efficient altitudes and speeds, to avoid bottlenecks in the airspace network. **Airspace modernisation enables aircraft to follow more efficient flightpaths** thereby reducing fuel burn and emissions per flight.

2.45 In today's operation, controllers tactically manage the complex interactions between climbing and descending traffic. Continuous climbs and descents are routinely interrupted because of a lack of capacity at the airport or in the surrounding airspace, requiring aircraft to return to level flight until they are able to continue climbing or descending. The introduction of these 'steps' of level flight means more time is taken for climbing aircraft to reach their optimum cruising altitude, increasing emissions and fuel burn per flight. Similarly, descending aircraft that level off require higher engine power and consequently increased fuel burn. **In modernised airspace, flights in lower airspace that are transitioning between the take-off or landing phase and the cruise in upper airspace would be able to climb and descend continuously more often**, thereby reducing fuel burn and emissions per flight.

2.46 Flights inbound to airports that operate at close to maximum capacity often suffer congestion that results in queuing and delays. In the current airspace structure, arrival queues are managed using holding patterns such as 'stacks' or 'arcs' that cause traffic to circle in lower airspace burning extra fuel and creating visual intrusion. Aircraft may also be held in take-off queues. **Modernised airspace will reduce the need for holding** by better managing arrival times through optimised routes and speeds, thereby reducing fuel burn and emissions per flight.

2.47 A 2018 NATS report into the technical feasibility of airspace modernisation in the south-east of the UK, commissioned by the Department for Transport, suggested

that modernising airspace in the UK offers the potential to reduce future CO_2 emissions within the affected south east airspace by up to 20% by 2050 compared with a growth scenario without modernisation and increased delay.[31] In the Jet Zero consultation, the Government recognised that a significant proportion of emissions reductions would come from improving the efficiency of the UK's existing aviation system, with airspace modernisation playing a key role.[32] The Government committed to working with the CAA as co-sponsors of the airspace modernisation programme, and to support the Airspace Change Organising Group in ensuring carbon savings are realised and that plans for airspace modernisation account for the introduction of zero-emission aircraft.

Limit, and where possible, reduce noise impacts

2.48 One of the most significant environmental impacts associated with the airspace, particularly at lower altitudes near airports, is aircraft noise. The AMS objectives lead to a set of deliverables for which the strategy is responsible. They do not aim to encapsulate the entire government policy on aviation noise.[33] Instead, the strategy aims to identify where airspace has a specific role relating to noise, as described below. Where planning decisions have been approved and enabled growth, which may adversely affect noise, noise impacts are considered through the airspace design process and clearly communicated.

2.49 Aviation noise performance has improved significantly in recent decades, driven by the introduction of quieter aircraft. **Airspace modernisation is expected to result in a further reduction in the average noise levels *per flight***.[34] Currently, flightpaths may not be optimised to reduce noise impacts or designed to offer relief from noise. For example, modernisation could enable aircraft to climb more quickly and descend more quietly, and to navigate more accurately around population centres or other noise-sensitive areas. Reducing noise impacts could itself be a driver for a new design.

2.50 However, the creation of more airspace capacity, while not directly generating more air traffic, can, where planning decisions allow it, facilitate further traffic

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31 *NATS Feasibility Report into Airspace Modernisation in the South of the UK and the CAA Assurance into the NATS Feasibility Report*, Department for Transport December 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/763085/nats-caa-feasibility-airspace-modernisation.pdf

32 The Jet Zero consultation includes a case study on carbon savings from testing of removal of the North Atlantic Track system.

33 For example, the Government expects industry to follow the ICAO 'Balanced Approach', but the strategic objective here focuses on the measures within that Balanced Approach where airspace is most relevant. The Government also imposes noise restrictions on night flights at certain airports.

34 Aiming to reduce the noise of individual flights means aiming for an average reduction per flight. It does not mean that there will be a reduction in noise on every individual flight, or that there will necessarily be an overall reduction in noise, as this will be dependent on the overall number of flights.

growth (because the outdated airspace design will eventually constrain the number of flights that the airspace can safely accommodate); a potential considered as part of the airspace change process's decision-making. The total impact on noise of modernisation is therefore dependent on several factors. What is more, modernisation may result in the redistribution of noise impacts between different areas on the ground, depending on the airspace design and the way it is used. Those changes may impact communities living under flightpaths in different ways, both positively and negatively.

2.51 Those who are affected by airspace change must therefore be engaged in the decision-making process, and fully informed of the benefits and drawbacks of such a transformation. The effects of new, more frequent or concentrated flight paths may increase the risks of causing general annoyance, sleep disturbance, lower levels of productivity and health impacts. The introduction of performance-based navigation routes can be used beneficially, for example by introducing, within practical limits, multiple flight paths for noise respite. However, the improved navigation precision can also result in greater aircraft (and therefore noise) concentration in certain locations.

2.52 In the Air Navigation Guidance 2017, the Government issued revised environmental guidance to the CAA to clarify that in assessing the number of people 'significantly affected by aircraft noise', the total adverse effects must be considered. This clarification of existing policy builds in an assessment of health impacts into airspace change proposals so that, for example, the creation of a respite route could reduce the total adverse health effects while increasing the absolute number of people affected. As a result, the aviation industry is required to consider options when designing airspace to find ways to manage the distribution of noise that best reflects this policy objective, including taking into account local circumstances and preferences.

2.53 Figures 2.1 and 2.2 give examples of the possible noise management options in a modernised airspace network. Figure 2.1 illustrates using the enhanced navigational accuracy of performance-based navigation to manage noise impacts by avoiding population centres. Figure 2.2 illustrates how an increased minimum climb gradient will, in general, result in some of the slowest-climbing aircraft reaching a higher altitude sooner in their vertical profile. This has potential operational benefits and also some noise benefits as, in general, noise experienced on the ground reduces with height. However, heavier aircraft may have to increase engine thrust to achieve the steeper gradient which may alter noise impacts and also reduce engine service life. More information and other examples are explained in CAP 1378.[35]

[35] CAP 1378 *Performance-Based Navigation: Airspace Design Guidance – noise mitigation considerations when designing PBN departure and arrival procedures* www.caa.co.uk/cap1378.

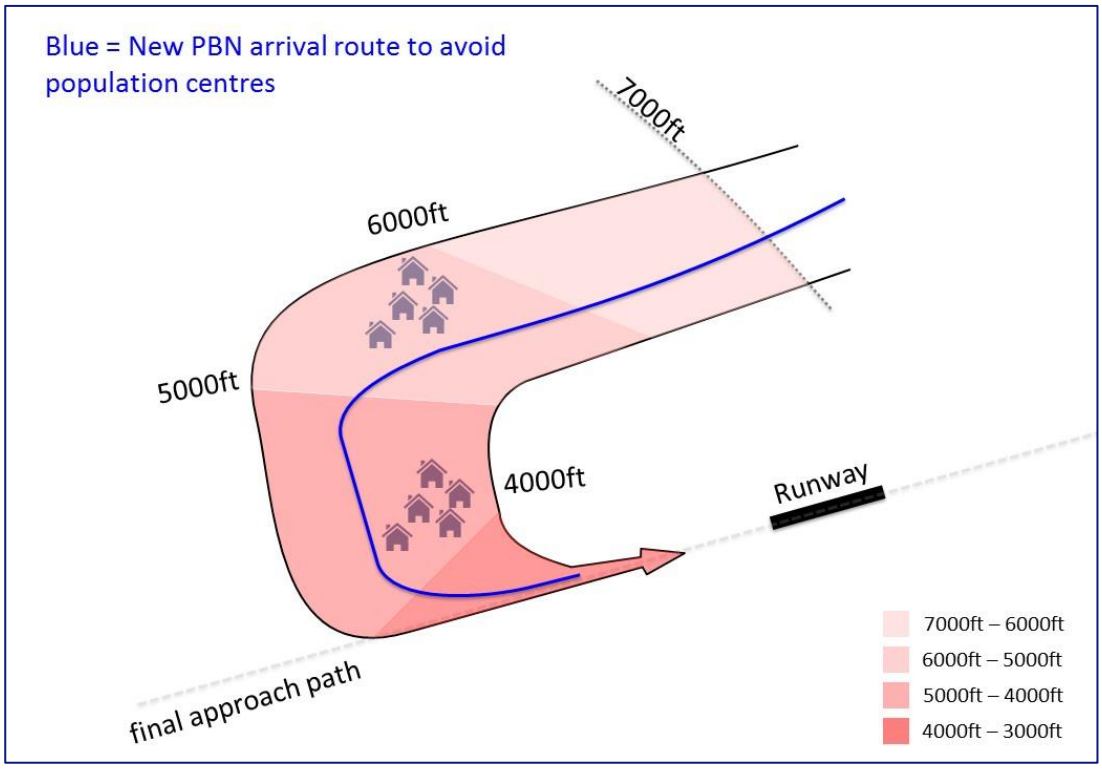

Figure 2.1: Illustration of a new arrival route using performance-based navigation to manage noise impacts by avoiding population

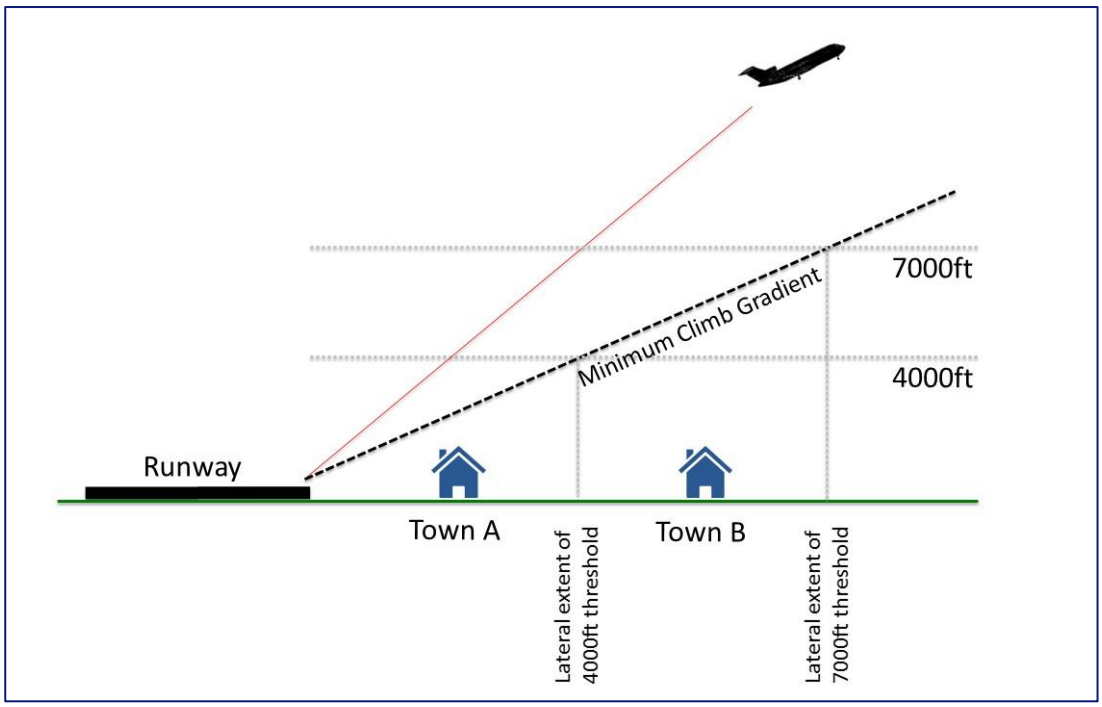

Figure 2.2: Illustration of an increased minimum climb gradient to lessen noise impacts through greater height over the ground

Source for Figures 2.1 and 2.2: www.caa.co.uk/cap1378

2.54 It is not the role of the airspace modernisation process to limit airspace capacity for each airport. Airport capacity at individual airports is dealt with through the planning process, for example, through limits on the number of passengers or flights at individual airports. The AMS therefore focuses on the impact that airspace design can have on limiting and, where possible, reducing aviation noise impacts.

2.55 The noise impacts of changes to airspace design are evaluated as part of the CAA's regulatory process for airspace change proposals under the CAP 1616 process. The sponsors of airspace change proposals are required to consider and find ways to manage the distribution of noise that best reflects this end of the AMS and the Government's environmental objectives, including taking into account local circumstances and preferences.

Local air quality

2.56 Due to the effects of atmospheric mixing and dispersion, emissions from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality.[36] Therefore, the impact of airspace design on local air quality is generally negligible compared to changes in the volume of air traffic and that of the local transport infrastructures feeding the airport. However, as part of the modernisation programme, the CAA evaluates whether local air quality could be impacted when assessing individual airspace change proposals under the CAP 1616 process.

B: Drivers for change

Meeting the demand for airspace, more sustainably

2.57 Aviation in the UK has grown significantly in the last 50 years driven by globalisation, the growth in real incomes and a greater desire from the public to travel abroad. The aviation sector brings significant benefits to the UK and is a key driver for future economic growth.

2.58 In 2018, prior to the Covid-19 pandemic, the Government was expecting demand to continue to rise significantly in the period to 2050[37], bringing increasing pressure on UK airspace. Flight delays were forecast to increase sharply if the UK's airspace was not modernised. Delays can lead airlines to build buffers into their flight schedules limiting the number of round trips that can be completed in a day, and therefore potentially reducing frequency to some destinations in order to maintain the reliability of their operation. The outcome is less choice, greater cost and inconvenience for passengers and shippers, and constraints on UK

36 ICAO Doc. 9889 Airport Air Quality Manual, Second Edition, 2020.

37 *Beyond the horizon, the future of UK aviation, next steps towards an Aviation Strategy*, HMG, April 2018. https://www.gov.uk/government/consultations/a-new-aviation-strategy-for-the-uk-call-for-evidence

connectivity and on UK economic growth. Modernisation therefore brings benefits for consumers in the form of choice and value. The strategic case for airspace modernisation and the resultant benefits were set out by the Department for Transport in 2017.[38]

2.59 At the time of writing, it is not clear how quickly, to what extent or in what form demand for air travel will return after the significant impacts of the global Covid-19 pandemic and how the sector will be affected over the longer term. As noted above, in October 2021 the Government reaffirmed that it wholeheartedly supported flying as a social and economic good, and believes that even if returning to a pre-Covid-19 demand trajectory, the UK could achieve net zero emissions without the Government needing to intervene directly to limit aviation growth providing technology solutions are implemented effectively.[39] The Government believes that airspace modernisation will form a significant part of its Jet Zero strategy in terms of short- to medium-term measures, allowing aviation to meet increasing demand in a sustainable way, including helping the UK meet its climate change obligations. As outlined under the environmental sustainability strategic objective above, more efficient operations facilitated by modernised airspace allow quicker, quieter and cleaner journeys.

2.60 Most flights using the UK's controlled airspace and route network are commercial air transport aircraft carrying passengers and freight. As traffic levels return post-pandemic, forecasts vary considerably as to when commercial air transport will recover to at least 2019 traffic levels. **Those forecasts also continue to change**. At the time of writing the more optimistic forecasts suggest 2023 and the more pessimistic ones suggest towards the end of the decade: Figure 2.3 shows a EUROCONTROL forecast for IFR (Instrument Flight Rules) flights in UK airspace (October 2021) – essentially those flights using controlled airspace.

2.61 The potential demand from new airspace users (such as remotely piloted air systems, advanced air mobility, space) is difficult to quantify, but in time could be very significant.[40]

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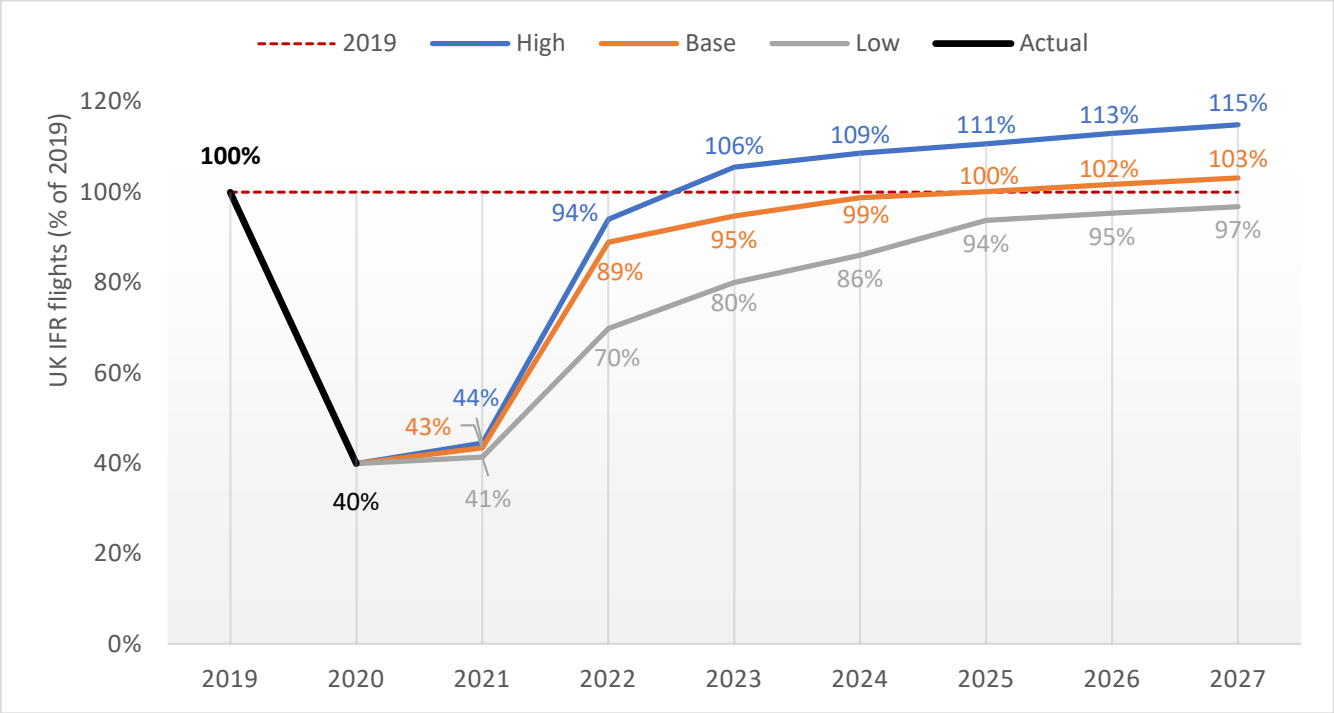
38 *Upgrading UK airspace, strategic rationale*, Department for Transport, 2017. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/586871/upgrading-uk-airspace-strategic-rationale.pdf

39 Climate Change Committee's 2021 progress report: Government response, HMG, October 2021. https://www.gov.uk/government/publications/committee-on-climate-changes-2021-progress-report-government-response We summarise the legal and policy framework in Appendix A.

40 See, for example, *Impact of Drones on the UK Economy: Skies without limits,* PwC 2018, which forecasts 76,000 drones in UK skies by 2030, of which more than a third will be used by the public sector. https://www.pwc.co.uk/issues/intelligent-digital/the-impact-of-drones-on-the-uk-economy.html.

Also see *European ATM Masterplan: Roadmap for the safe integration of drones into all classes of*

2.62 The AMS must take into account changing trends, including any structural changes in air travel or changes in the types and numbers of airspace users, and must look at the long-term outlook. If these forecasts are realised modernisation will be needed to secure the most efficient use of airspace and the expeditious flow of traffic in a safe and sustainable way.



Note: Forecast published October 2021.
https://www.eurocontrol.int/publication/eurocontrol-forecast-update-2021-2027

Figure 2.3: Eurocontrol seven-year forecast of future UK IFR movements vs 2019 (October 2021)

Encouraging aviation innovation to support UK economic growth

2.63 Technology will drive radical changes in transport in the next 10 years, with profound implications for transport users and businesses. Electrification, connectivity, automation, and real-time data usage are driving the development of new modes of travel and new ways to do business. Part of the UK's industrial strategy, the Government's Future of Transport programme[41] aims to stimulate innovation in the transport sector, create new transport markets, secure a 21st-

airspace, SESAR March 2018:
https://www.sesarju.eu/sites/default/files/documents/reports/European%20ATM%20Master%20Plan%20Drone%20roadmap.pdf

41 https://www.gov.uk/government/collections/future-of-transport-programme

century transport system, and secure the UK's position as a world-leading innovator, decarbonising the transport system for the benefit of all society.

2.64 The Government's ambition is for the UK to lead the world in innovative aviation technology that has a transformative effect on the movement of people and goods, and delivers tangible benefits to communities, industry and users in a safe, secure and sustainable way.

2.65 These emerging forms of aviation are developing rapidly and will create new ways to travel and new forms of aviation. Examples include remotely piloted aircraft systems (drones)[42], advanced air mobility (aerial taxis), high-altitude platform systems including balloons (for example, to provide a telecommunications network), commercial spacecraft (launching from the UK), and upper-atmosphere supersonic and hypersonic flights. Some of these users, although labelled as new entrants, have actually been operating for several years. Technology has increased the ease and cost of their manufacture and operation, which has expanded the range of use, including surveying, delivering products and proving telecommunications, serving new locations and providing new or existing services to society in a new or more cost-effective way, creating jobs and economic activity.

2.66 Drones can be remotely piloted or autonomous and are used for civil or military aviation purposes. They may require changes to airspace structures and rules if they are to integrate seamlessly into UK airspace alongside the demand for commercial air transport flights, military activities, and an active General Aviation sector. The commercial spaceflight sector is also now becoming a reality. These innovative technologies not only affect what flies, but also how aircraft are flown, meaning new concepts for operating aircraft are also emerging.

2.67 Such a high rate of change cannot be accommodated within the current airspace structure. Incorporating this ever more complex and growing mix of traffic requires advanced technological tools and air traffic management solutions. For example, to progress electronic conspicuity, the CAA and Department for Transport have formed a task force, working with manufacturers, to develop and publish common specifications enabling interoperability between airspace users and service providers. This will enable future airspace design to accommodate better information sharing accurately and reliably, promoting safe integration and growth for all the different users of airspace. Compliance with the specifications

[42] Remotely piloted aircraft systems (RPAS) may be referred to as unmanned aerial vehicles (UAV), uncrewed aircraft, drones, model aircraft or radio-controlled aircraft. For more information see https://www.caa.co.uk/Consumers/Unmanned-aircraft/Our-role/An-introduction-to-unmanned-aircraft-systems/

will be required in airspace where mandated, but outside that airspace, users can still benefit from using these or other systems that give useful functionality.

2.68 The economic and financial models that will be used to deliver the services required by new types of airspace users will also need to be developed. In the electronic conspicuity example above, some users of airspace may need to adopt new equipment or adapt existing devices to meet the new specifications. The Department for Transport and CAA will set out more details in due course about support to help manufacturers and airspace users make those changes. As regards environmental impact, as noted earlier, the CAA anticipates that the owners and operators of advanced air mobility and remotely piloted or unpiloted aircraft systems will be subject to the same, or similar, statutory requirements relating to noise as other airspace users.

International obligations

2.69 The UK's international treaty obligations, in particular adherence to the ICAO GANP, is a significant driver of airspace modernisation. The UK also needs to maintain interoperability with the systems and procedures of international partners to ensure connectivity and efficiency of cross-border operations.

Facilitating defence and security objectives

2.70 The military relies on access to airspace to help secure the UK's borders and carry out training. Military aircraft, land and maritime systems use the full range of upper, lower and terminal airspace, including all classifications of airspace. These operations sometimes require dedicated areas to be reserved for activities which may be hazardous to other airspace users such as high-energy manoeuvring and testing munitions.

2.71 Military airspace requirements are under constant review as a result of technological developments, geopolitics and government direction. The UK and its allies have brought into service more technologically advanced and capable aerial systems, for example 'fifth-generation' fast jets and large remotely piloted aircraft systems. Although tactical training for this latest generation does include the use of ground-based simulators and training systems, it is anticipated that it will also drive greater airspace requirements over the next 10 years and the need for specialised training airspace will continue to evolve. To exercise the full capability of fifth-generation systems and present a sufficient training challenge, airspace must accommodate areas of an appropriate size and shape that allows tactics and systems to be fully and realistically tested.

2.72 Much of the current special-use airspace was developed to support the operational and training needs of aircraft and systems now retired, and it is neither optimal for current missions nor emerging requirements. Together with other new platforms such as remotely piloted aircraft systems based in the UK,

new weapons technology and operational approaches, these bring a new airspace requirement.

C: The benefits and impacts of airspace modernisation

2.73 We have described above the strategic objectives for modernisation, and the main drivers. This section considers the benefits and impacts from the perspective of individual stakeholders. This theme is picked up in the use cases in Chapter 5. Modernisation will also provide flexibility within the system to enable continuing development and improvement of UK airspace in the future.

UK economy

2.74 The capacity to add routes, accommodate new flights, make existing operations more efficient and encourage new technology will enhance the UK's global connections, give better value and more choice for businesses and individual travellers, helping to stimulate UK economic growth benefiting the UK population.

Passengers and shippers

2.75 Modernisation will add capacity to the system, addressing 'hotspots' of congestion within the current system that may otherwise give rise to delays, such as 'stacking' in holding patterns by flights inbound to an airport. Modernisation will generally improve resilience of the system to bad weather or other forms of disruption, including disruption in neighbouring airspace outside the UK's area of responsibility.

2.76 Passengers and shippers (including companies in the supply chain that rely on air transport to conduct their business) will therefore experience fewer flight delays and service disruptions at short notice, saving them time through shorter journeys with a more reliable service. Coupled with the improvement in the passenger experience, increased capacity may allow more choice of connections to more destinations.

Climate change impacts

2.77 The Government expects that to meet its commitment to achieving net zero emissions, a significant proportion of the emissions reductions will come from improving the efficiency of the existing aviation system, including aircraft, airports and airspace. These efficiency improvements also offer the best opportunities for short- to medium-term emissions reductions, given the lead times associated with other measures, such as sustainable aviation fuels and zero emissions flight. In the longer-term, modernisation will reduce the need for potentially expensive climate mitigations such as carbon capture and storage.

2.78 Airspace modernisation will therefore be an important contributor to reducing UK aviation carbon emissions. Where aircraft are able to follow more fuel-efficient

routes, wider society will also benefit from the reduction in climate change impact.

Communities impacted by aircraft noise

2.79 The fourth strategic objective on environmental sustainability above explains the environmental improvements that airspace modernisation can offer to communities[43] impacted by aircraft noise – as a result of designing airspace around the more advanced technology available and better aircraft performance. It also explains that not every community will benefit.

2.80 When an airport is changing airspace (for a planned increase in capacity or any other reason) it must develop its design proposal in accordance with policy and law and follow the CAA's airspace change process.[44] In the Air Navigation Guidance 2017, the Government has also provided guidance[45] to the CAA and industry on how the decisions they make can best give effect to the Government's key environmental objectives, including managing the impacts of aircraft noise.

2.81 The objectives of the AMS are also bound by this overarching government policy. The AMS can only be responsible for delivering noise reduction where it has an element of control. Where a decision has been taken through the planning process to increase airport capacity, this is outside the responsibility of the strategy. The objectives of the strategy therefore do not focus on the overall level of noise, as this is in part contingent on planning decisions and government policy.

Aircraft operators

2.82 **Access:** UK airspace will more readily and more safely accommodate additional demand from airspace users, including:

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43 When referring to 'communities' this strategy document generally means those on the ground affected by aviation's environmental impacts in the vicinity of an airport, usually by noise but also sometimes local air quality (where there is an impact on the distribution or volume of emissions below 1000 feet). Communities may in turn be represented in different ways: by local authorities and elected representatives in national or local government; community leaders or representative groups/forums, airport consultative committees, and bodies with an interest in aviation's environmental impacts.

44 In respect of which the Secretary of State has given Directions to the CAA, see Air Navigation Directions at https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Legislative-framework-to-airspace-change/.

45 Section 70(2) of the Transport Act 2000 states that the CAA "must exercise its air navigation functions in the manner it thinks best calculated […] to take account of any guidance on environmental objectives given to the CAA by the Secretary of State..." https://www.gov.uk/government/publications/uk-air-navigation-guidance-2017

- commercial airlines providing a key element of the UK's transport infrastructure, supporting connectivity, better choice and value for consumers and UK economic growth.
- the General Aviation sector, including recreational flyers, by providing greater access to the controlled airspace predominantly used by commercial air transport flights, greater integration of different types of airspace user, or more flexible use of airspace, as described in more detail under 'integration' above.
- new technologies currently being deployed that are changing the types of aerial craft and how they operate. These new aerial craft include remotely piloted aircraft systems (drones), advanced air mobility and high-altitude platform systems (for example, to provide a telecommunications network). Rather than having to segregate these operations from other types of airspace user, and therefore potentially restrict those users' access to that segregated airspace, these new users – with the exception of space-launch activities – would gain better access through more integrated airspace.
- space-launch activities that will require segregation for limited periods of time; although we would seek to utilise, while further refining, existing processes to enable those activities, similar to the need for segregation for military and related activities.
- the Ministry of Defence. Timely access to appropriate airspace is essential for the maintenance of military capability. Modernisation of airspace structures, systems and processes helps to secure the most efficient use of airspace consistent with ever-changing safety, defence and security objectives. It creates greater opportunities and options for the integrated operation of air traffic services provided by or on behalf of the Ministry of Defence, while also allowing non-military traffic to access more effectively what might otherwise remain segregated areas when they are not in use.

2.83 **Cost:** The airspace structure is a key determinant of an operator's costs, punctuality and environmental performance. More direct and efficient flight paths will mean lower costs for operators because they will save on fuel and increase the utilisation of their aircraft. Commercially, operators will be able to offer a more attractive proposition.

Airport operators

2.84 Sharing digital information about the inbound and outbound traffic flows using the airspace is expected to improve runway throughput and resilience to disruption through greater traffic predictability. Additional airspace capacity will give airports more scope to develop their operations in line with their business plans, subject

to planning considerations.[46] Enhanced technology combined with updated airspace design enables safe, expeditious and efficient management of increased traffic and increases operational resilience.

Air navigation service providers

2.85 More capacity and more efficient use of modernised airspace will help to alleviate the current significant air traffic control workloads that can occur at times of high demand, during bad weather or other forms of disruption. Modernisation will facilitate the need for interoperability of the UK network with neighbouring transatlantic and European air traffic management areas, given the need to manage air traffic effectively end to end.

Government

2.86 As explained above in respect of the UK's climate change commitments, the Government's Jet Zero consultation recognises that a significant proportion of aviation emissions reductions will come from improving the efficiency of the UK's existing aviation system, with airspace modernisation playing a key role.

2.87 Airspace modernisation must implement both domestic and internationally agreed requirements designed to increase the overall safety, capacity and efficiency of the global air traffic management system, while making commensurate environmental improvements. International requirements are driven by the ICAO Global Air Navigation Plan, described above and in Chapter 3.

2.88 The UK manages part of the North Atlantic's oceanic airspace, a gateway between Europe and North America. This airspace is the world's busiest oceanic, intercontinental air corridor, and its efficient operation is crucial for international air traffic management.[47]

[46] It is important to note that at some airports, where a planning authority has placed a condition which limits the number of aircraft or passenger movements, and where an airport has reached that limit, additional airspace capacity created to deliver safe and efficient growth of commercial aviation can only be used if and when planning approval is given for airports to grow.

[47] Air traffic services in the eastern half of North Atlantic airspace are provided by NATS on behalf of the UK under its obligations to ICAO.

Chapter 3

Key ways of modernising airspace through ICAO GANP

Chapter summary

This chapter gives an overview of the key 'ways' of achieving modernisation of UK airspace (more detail is in Parts 2 and 3 of the strategy). The key 'ways' are based on:

- the ICAO ambition for modernisation through the Global Air Navigation Plan (GANP), which the UK is bound by international treaty to implement
- the building blocks of the GANP, known as Aviation System Block Upgrades (ASBUs)
- evolutionary steps for modernisation, using the ASBU framework
- workstreams organised into ASBU 'threads' and elements under three headings:
  – information
  – operational
  – communications, navigation and surveillance technology and services

Introduction

3.1 A comprehensive modernisation programme across UK airspace is needed to achieve the 'ends' described in Chapter 2. This chapter explains the key 'ways' of doing this, based on ICAO's Global Air Navigation Plan (GANP), and how the strategy tailors the building blocks of the GANP to the specific requirements of UK airspace.

ICAO Global Air Navigation Plan (GANP)

3.2 The global ambition for airspace modernisation is set out by ICAO in the form of the Global Air Navigation Plan (GANP).[48]

3.3 The GANP drives the evolution of the global air navigation system; its stated purpose is to equitably accommodate all airspace users' operations in a safe, secure and cost-effective manner, while reducing aviation's environmental impact. To this end, the GANP provides a series of operational improvements to increase capacity, efficiency, predictability and flexibility while ensuring

[48] https://www4.icao.int/ganpportal/

interoperability of systems and harmonisation of procedures. The GANP is supported by the ICAO Global Air Safety Plan (GASP).[49]

GANP Aviation System Block Upgrades (ASBUs)

3.4 Aviation System Block Upgrades (ASBUs) are the building blocks of the GANP. They provide a global planning framework to ICAO and its member states, associated air navigation service providers and other stakeholders with the goal of implementing regional performance improvements.

3.5 The ASBU concept focuses on four performance improvement areas: airport operations; global interoperable systems and data; optimum capacity and flexible flights; and efficient flight paths. Work-streams are organised into 'threads' and 'elements', under three headings, that together will, over time, deliver those performance improvements (Figure 3.1). ASBUs outline the air and ground equipment and timelines for standards and procedures implementation.

ASBU series of system upgrades designed to meet GANP objectives

- Block 0 2013 – 2018
- Block 1 2018 – 2023
- Block 2 2023 – 2028
- Block 3 2028 – 2033
- Block 4 2033 +

ASBU threads:

- Information
- Operational
- CNS Technology and Services

3.6 More information about how these ASBUs translate to the UK airspace modernisation programme is in Part 2 of this strategy.

[49] The GASP promotes the effective implementation of safety oversight and a safety management approach to oversight, including safety risk management to permit innovation in a managed way. https://www.icao.int/safety/GASP/Pages/Home.aspx

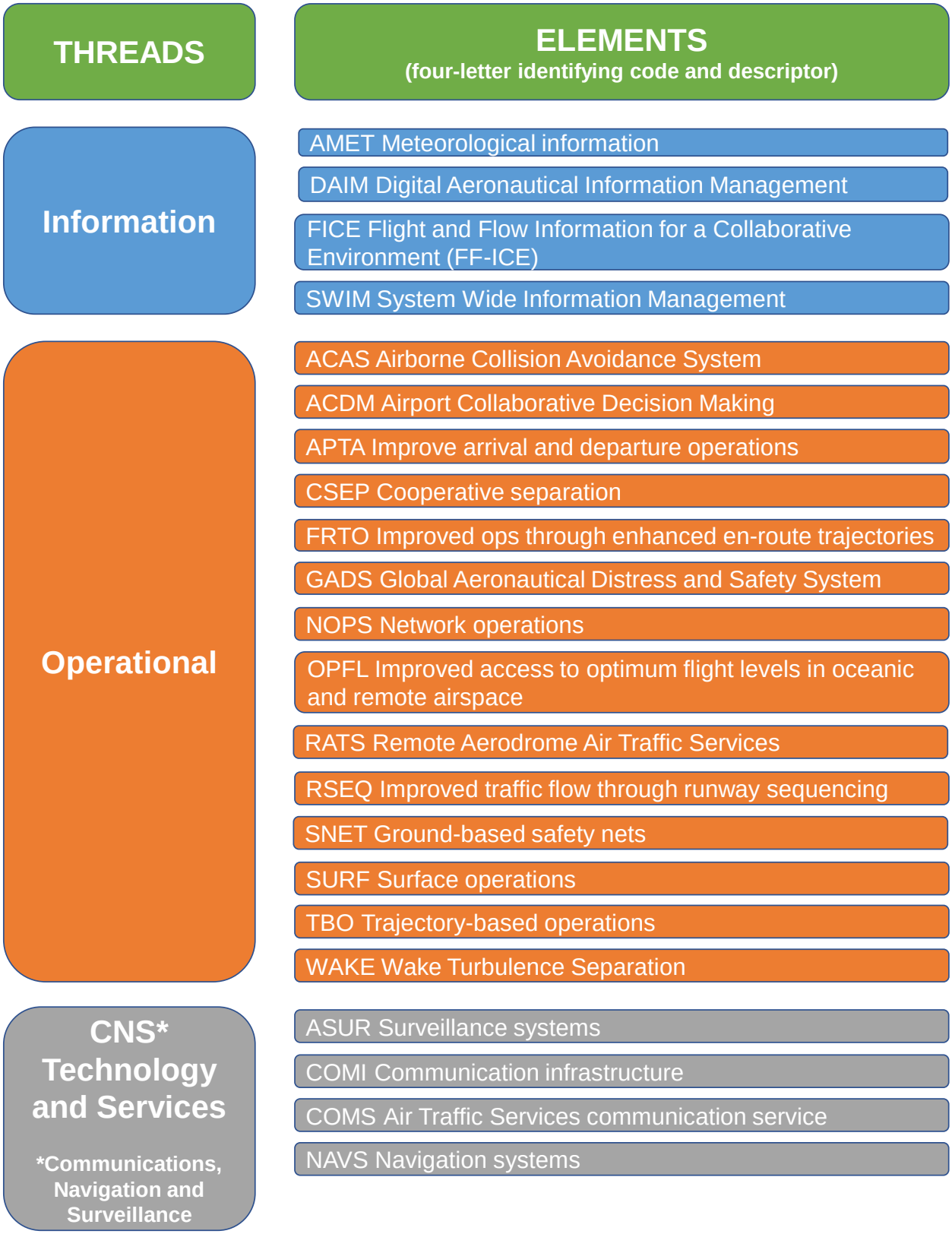


Figure 3.1 ICAO ASBU threads and elements

Key ways of modernising airspace

3.7 The air navigation system is becoming more complex as it supports new demand. To manage this complexity, meet the global performance ambitions and realise the GANP's purpose in the UK, the air navigation system must transform and build upon the use of emerging technologies, information and concepts of operations, many of which are not specifically designed for aviation purposes.

3.8 This evolution of the air navigation system is built on the notion of management by trajectory, empowered by access to timely and accurate shared information, which should improve mission and business trajectories[50] for both commercial and non-commercial operations.

3.9 Information exchanges between airspace users, air traffic management systems and aerodrome operations ensure that timely and consistent decisions are made on a network and flight-centric basis. New entrants such as spaceport operators, commercial space operators and new users of high-altitude airspace will all contribute to this dynamic decision-making process.

3.10 This evolution will be enabled by a progressive increase in automation, advancements in technology and the use of standardised, interoperable ground and air systems in an integrated infrastructure. This aviation infrastructure, based on the sharing of relevant operational information, will be able to interface with non-aviation transportation systems to achieve an efficient, multimodal transport system.

3.11 The conceptual roadmap presented below is aimed at not just improving but transforming the air navigation system, based on its strengths and opportunities, by providing a more holistic approach to its evolution.

Evolutionary steps, aligned with the ASBU steps

Evolutionary step 1: Flight operations in a digital-rich environment

3.12 Air navigation resources are limited. In a safety-critical environment, the capacity of the system relies on the ability to exploit air navigation resources. To unlock the inherent capacity of the system and allow more scheduled flights, a move towards a more tactical data environment is required. Without the necessary accurate data, the number of flights that can be handled is restricted. Real-time

[50] All partners in the air traffic management network will, wherever possible, share trajectory information in real time from the earliest trajectory development phase through operations and post-operation activities. Air traffic management planning, collaborative decision-making and tactical operations will be based on the latest trajectory data. A 'business trajectory' for civil aviation or a 'mission trajectory' for military operations is developed and agreed for each flight, resulting in the trajectory that a user agrees to fly and the air navigation service provider and airport agree to facilitate.

digital data would allow much better tactical management by service providers in the future, eliminating the possibility of excessive holding, sector overloads or diversions.

3.13 These limits on airspace and runway capacity currently result in delays, passengers receiving poor service and a loss of potential opportunities to accommodate demand and to improve environmental efficiencies. Airspace modernisation must embrace the opportunities that digital technologies are creating in order to unlock benefits for aviation, consumers and the environment.

Evolutionary step 2: Time-based operations enabled by an information revolution

3.14 Aviation is a global 'business of businesses' where customer satisfaction depends on the aviation system's predictability. Customer satisfaction varies from the passengers arriving at their destination on time, to the airlines maintaining daily schedules. Although the digital transformation has increased the capacity of the air navigation system, the isolated (local) nature of decisions can result in unforeseen delays to schedules and customer dissatisfaction, along with additional costs and inefficiencies. The second evolutionary step is therefore to adopt a regional, rather than local, approach to flight operations based on the timely integration of information.

Time-based operations: helping to manage traffic flows and trajectories by scheduling and metering aircraft through congested airspace resources or constraint points. Metering means time-regulating arrival traffic flow into a terminal area so as not to exceed a predetermined acceptance rate.

Evolutionary step 3: Trajectory-based operations enabled by full connectivity through the internet of aviation

3.15 One of the barriers to improving the regional air navigation system is the lack of full participation because the high cost of aviation-specific technologies is less affordable for some airspace users. Sub-optimal traffic management decisions are therefore made to accommodate all stakeholders. The lack of information on current wind, turbulence and weather conditions, resulting in a less accurate definition of constraints, is also part of the issue. Finally, the inability to connect cross-regional information sources is affecting global flights and the ability of air navigation service providers and airspace users to further plan their operations. A move toward the global secure intranet of aviation will reduce such costs and inefficiencies.

Trajectory-based operations: Defined in four dimensions (4D) – latitude, longitude, altitude and time – the trajectory represents a common reference for where an aircraft is expected to be – and when – at key points along its route. The trajectory is defined prior to departure, updated in response to emerging conditions and operator inputs, and shared between stakeholders and systems. The aggregate set of aircraft trajectories on the day of operation (operating conditions on that day including operational issues, weather etc) defines demand, and informs traffic management actions.

Evolutionary step 4: Total performance management system focus on business/mission needs

3.16 Moving passengers and cargo worldwide is not the sole purpose of aviation. The emergence of multiple airspace users and different vehicles and business models has added significant complexity to decision-making among air navigation service providers. Without flexibility in the decision-making process, ultimate customer satisfaction will not be met. Air navigation service providers will only meet these various new demands by managing the process that enables their direct customers and other stakeholders to make their own operational and business focused decisions, based on pre-defined system performance requirements.

ASBU threads

3.17 The key ways to deliver these four evolutionary steps use the ASBU framework of threads and elements under three headings (Figure 3.1 above):

- Information – new systems improving connectivity into the network and information-sharing
- Operational – aircraft capability and airspace management

- Technology – CNS (Communications, Navigation and Surveillance) technology and services.

3.18 Below we explain more about each of these, from a UK airspace perspective. Chapter 4 sets out how these GANP threads and elements translate to UK delivery elements (pages 58 to 62).

Information

3.19 This involves the deployment of new air traffic management systems and tools to improve connectivity into the network and share accurate flight information about traffic flows. This includes meteorology, aeronautical information, Flight and Flow Information (FF-ICE) and System-Wide Information Management (SWIM) elements.

Data sharing (SWIM)

3.20 System-Wide Information Management (SWIM) is a global air traffic management initiative to harmonise the exchange of aeronautical, weather and flight information for airspace users, civil and military air navigation service providers, airport operators, meteorological service providers and the European Network Manager. In simple terms it is a web-based cloud for aviation data. At present there are multiple systems for weather, flight planning, airspace notification etc, whereas SWIM will locate all the data in a single network.

3.21 For example, at present, information from multiple sources is required to plan a flight. Some or all of that flight information is provided to airspace service providers, whether as a flight plan, an airfield bookings request or request for air traffic services. Once airborne, that information stops or is not as forthcoming. Through SWIM, a single compatible system could enable a flight operator to plan a flight, with the system pulling in weather, airfield, airspace and other pertinent information. Once planning is complete, the information is submitted to the system for other users to use, not just in the traditional method, but also to provide situational awareness to the wider airspace user.

3.22 Once airborne, live flight information continues to be provided in real time; moreover, airspace users could also provide local information to the system such as weather and un-notified hazards. This information would also allow air traffic service providers to better plan service provision based on real activity, airfield operators to declare capacity more accurately, enabling bookings and planning of arrival and departure slots to minimise delays more efficiently, or enable operators (piloted or remotely-piloted) to operate where and when they want through better self-management of their activity. Such systems already exist for car drivers where satellite navigation provides fastest or most economical route options based on real-time traffic or disruption information, which is updated en route.

Operational

3.23 This thread can be explained under three headings, integration and flexibility; simplification; and sustainability.

Integration and flexibility

3.24 The strategic objective is a single airspace in which all airspace users may operate. Achieving this requires:

- traffic management services based upon digital data exchange between ground service providers and all types of aircraft
- separation services provided by a variety of means, for example evolving the current human-based tactical air traffic control service to become more automated
- airspace management for high-altitude airspace operations
- airspace management for low/urban airspace operations
- developing airspace structures and enabling technologies for the greater integration of piloted and remotely piloted operations as well as continuing to enable sport and recreational operations to better self-manage their desired operation when and wherever possible
- continued provision of joint and integrated air traffic services between the CAA, NATS (En Route) plc and the Ministry of Defence in accordance with the Air Navigation Directions.

Simplification

3.25 With alignment of the AMS with the ICAO GANP in mind, achieving this requires:

- airspace designed to better enable integration for all users
- flexible access to airspace, such that the airspace, or part of it, will flexibly switch to an appropriate (usually dictated by safety considerations) classification or segregation, when necessary
- CAA-mandated classification of certain volumes of controlled airspace where required, based on published parameters such as the number of IFR traffic movements or complexity
- complete redesign of the route network in busy terminal airspace to take account of advances in new technology, especially satellite navigation and alternative position navigation and timing (A-PNT) systems for resilience, and to realise the potential for system design optimisation

- removal of the fixed structures in en route airspace, adding capacity and enabling more direct and free routes
- 'future-proofing' new airspace designs today to enable emerging requirements for Free Route Airspace and trajectory-based operations, thus minimising the potential need later on for lengthy changes in airspace design
- more use of transponder mandatory zones and radio mandatory zones (TMZ/RMZs) that have less impact than controlled airspace
- a Transition Altitude standardised at one altitude, for example 6,000 feet
- use of planned future means of surveillance and technology (SWIM, data sharing).

Sustainability

3.26 Those aspects relating to airspace modernisation include:

- redesigning airport arrival and departure routes at lower altitudes to allow flights to climb and descend continuously, improving CO_2 performance and better management of aircraft noise
- other improvements in airspace design listed under 'Simplification' above
- minimising ground taxi distances and runway hold times with engines running, or ground taxi with reduced engine power or alternative power sources
- potential for avoidance of persistent contrail development[51]
- reducing adverse weather impacts, such as holding, through better access to meteorological information to improve resilience planning and tactical interventions
- efficient and sustainable use of CNS (Communications, Navigation and Surveillance) technology across the aviation sector.

Technology – integrated Communications, Navigation, Surveillance and Spectrum approach

3.27 This involves the modernisation of communications, navigation, surveillance and radio-frequency spectrum (CNS&S) infrastructure to support the migration to predominantly space-based technology; and to provide contingency by using a

[51] There is uncertainty over the exact climate impact of contrails. We will keep under review the evidence of their impact and potential means of mitigation.

mixture of ground-based technology and multi-frequency, multi-constellation capabilities to mitigate any vulnerabilities of satellite navigation.

Ambition

3.28 The ambition is to provide an integrated airspace resource through enabling technologies that will allow new airspace users to flourish while preserving existing operational ambitions. But a modernised, integrated airspace cannot be delivered by changes to the airspace structure alone. CNS technology developments also form part of the critical supporting infrastructure and are the foundation of aviation's operational performance, helping to create the additional capacity that modernisation demands.

3.29 CNS has traditionally utilised extensive ground-based infrastructure to support the operation. This is increasingly transitioning to being space-based, retaining a limited, but vital, core ground infrastructure to provide resilience (Figure 3.2).

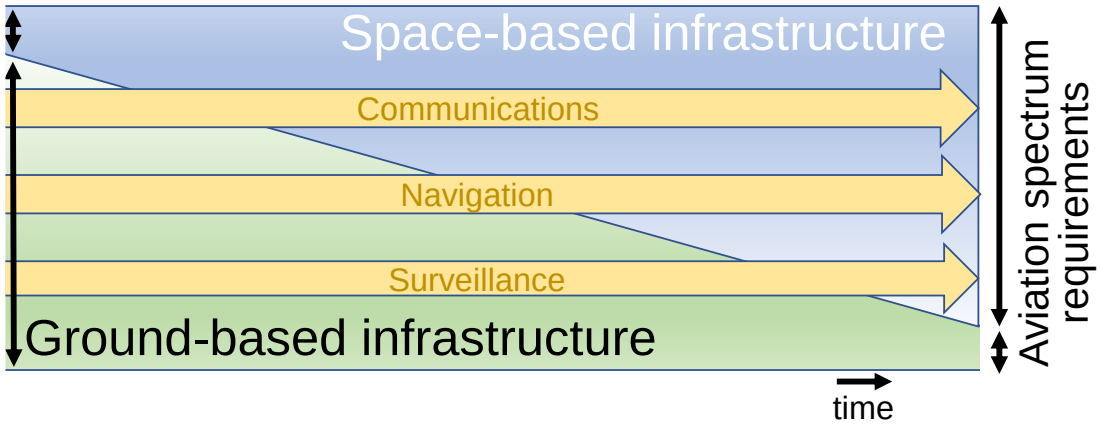


Figure 3.2 CNS shift from ground-based to space-based infrastructure

3.30 The core space-based infrastructure and the need for frequency spectrum (see below) are common enablers across all three strands of CNS services. We therefore consider CNS holistically with integrated requirements and similar service risks.

3.31 Commonality and interoperability are required across airspace users to ensure safe integration of the different operations. This will require coordination and investment across all stakeholders to deliver the necessary changes.

Integrated CNS

3.32 Integrated CNS is the next generation of CNS technologies supporting the modernisation and interoperability of the global air traffic management system

envisaged by GANP in terms of airport operations, globally interoperable system data, optimum capacity and operational trajectories.

3.33 In 2018 ICAO resolved “to launch a study, built on a multi-disciplinary view of the C, N and S elements and frequency spectrum, to evolve the required CNS and frequency-spectrum access strategy and systems roadmap in the short, medium and long term, in a performance-based and service-oriented manner, to ensure that CNS systems remain efficient users of the spectrum resource".

3.34 This work was initiated under the Integrated Communication Navigation Surveillance and Spectrum – (ICNSS) project. The ICNSS project has two main tasks:

- ICNSS Roadmap, leveraging recent advances in the state-of-the-art of telecommunications technology, focusing on the medium and longer term, to ensure that the aviation sector remains a responsible user of spectrum resource
- CNS Standards, to define revised Standards and Recommended Practices (SARPs) and International Specifications/Standards Framework methodology, leveraging a more performance-based approach for CNS SARPs and better links to international industry specifications and their validation as required.

Communications

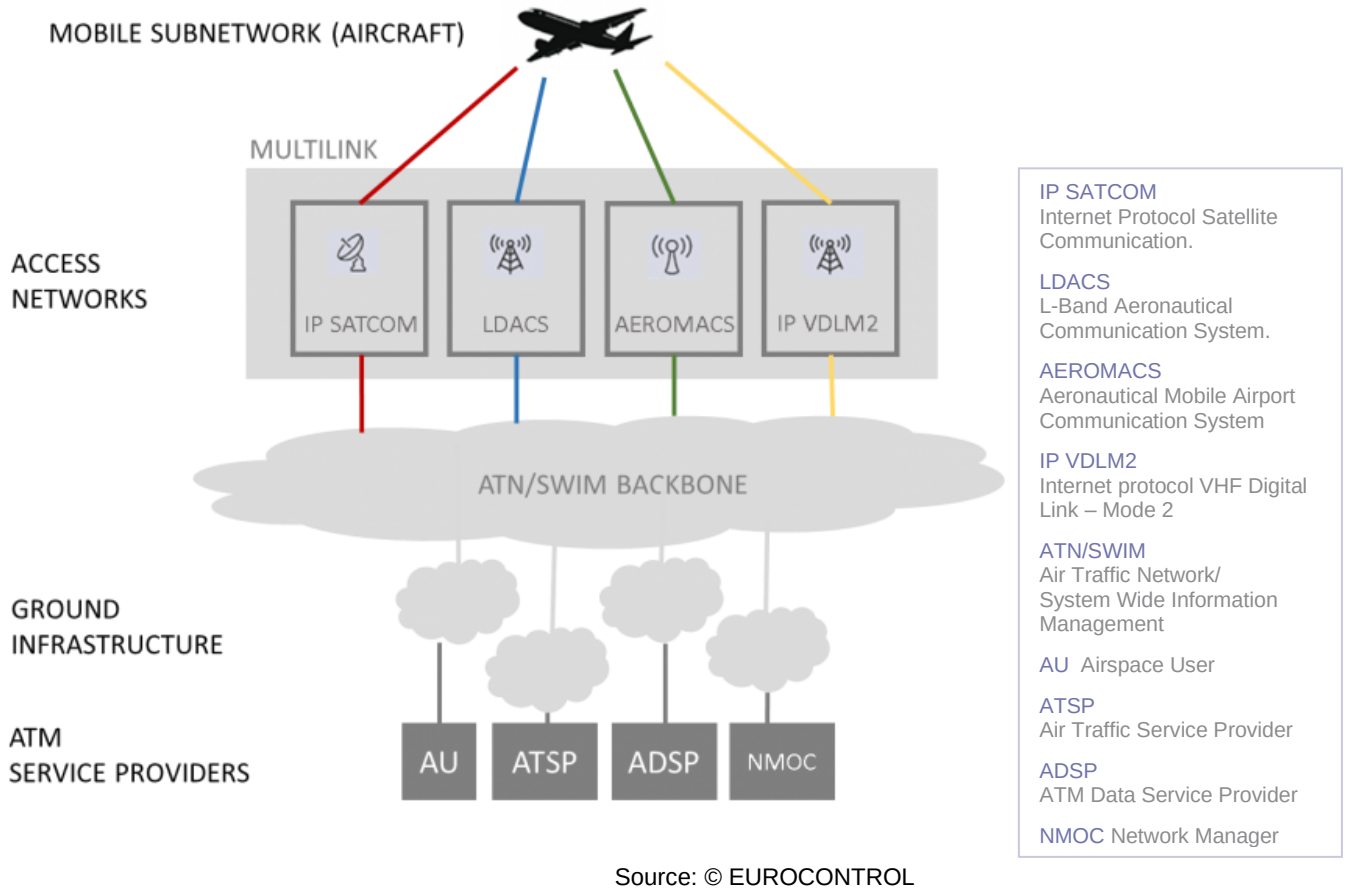
3.35 Efficient and stable communication channels are the bonds that ensure aviation operates efficiently, predictably and safely. They ensure that information exchange among airspace users is efficient, timely, accurate and reliable.

3.36 In order to increase efficiency and capacity, the aviation community is progressively digitalising its data exchanges with less reliance on voice exchanges over radio. This involves replacing or enhancing legacy communications systems to allow the digital transfer of flight-critical data and voice communications between aircraft and between aircraft and air traffic management services on the ground, reducing pilot and air traffic controller workloads and also providing interoperability and coordination with military flights. Initially this is likely to replace standard air traffic message exchanges, with more complex interactions developing as experience develops. Ground asset requirements for security, contingency and operational resilience of datalink communications need to be co-ordinated and managed.

3.37 Full 4D trajectory-based operations require higher datalink communication capacity and performance. In the long term, current technology is expected to be complemented by new datalink technologies with increased capabilities supporting more stringent operational requirements: satellite communications, L-band Digital Aeronautical Communication System and Aeronautical Mobile

Airport Communication System. This next generation of aeronautical communication infrastructure will be service-oriented and performance-based, in order to support rationalisation, reliability and efficiency of the communication capabilities (Figure 3.3).

3.38 The Future Communications Infrastructure (FCI) is a new Internet Protocol Suite (IPS) System providing the digital and secure communication capabilities able to support integrated Communication, Navigation and Surveillance (CNS). It provides the network functionality necessary to interconnect air and ground end-systems via multiple IP broadband air/ground datalink (multilink) subnetworks and core networks (NewPENS) to support aeronautical data and voice applications for safety and regularity of flight. The FCI is based on communication standards including Aeronautical Telecommunications Network (ATN)/IPS and System-Wide Information Management (SWIM) to define the interoperability features needed for data exchange and network management functionality. The FCI is also expected to interface with external networks for legacy ATN/OSI (Open Systems Interconnection) system accommodation, civil-military coordination and information exchanges with commercial IP networks.



Source: © EUROCONTROL

Figure 3.3 Future use of datalink communication technology

Navigation

3.39 Navigation is a key enabler of aviation, involving sophisticated technology and efficient coordination between pilot and air traffic controller. And yet, knowing where an aircraft is and how it will get to its destination is still a challenge – laterally (the aircraft must follow the route centreline); vertically (the aircraft must remain at the right altitude, even when climbing or descending); longitudinally (being over a particular point within permitted margins); and temporally (reaching a point within a particular time); hence the term 4D trajectory (three-dimensional position with time as the fourth dimension).

3.40 The avionics capability of the aircraft fleet has advanced significantly in the past two decades, allowing a shift from the reliance on wholly ground-based navigation beacons to autonomous aircraft operations utilising a more accurate space-based Position Navigation and Timing (PNT) source. Consequently ICAO member states are required to submit a national implementation plan for the introduction of performance-based navigation routes that can utilise both ground- and space-based PNT sources.

3.41 The aim is to develop robust positioning based on satellite navigation for all phases of flight, taking advantage of signals from multiple constellations, using GNSS (Global Navigation Satellite Systems), for example GPS (Global Positioning System). There will be a strong emphasis on providing final approach guidance for low-minima approaches (i.e. the criteria, such as cloudbase and visibility, used by pilots to determine whether they may land on a runway).

3.42 The greater use of performance-based navigation, and consequent rationalisation of old navigation equipment with its associated procurement and maintenance costs, is expected to:

- support the use of electronic conspicuity in the provision of surveillance service by Flight Information Service Officers (FISO), enabling safe integration of approach operations at smaller General Aviation aerodromes
- provide an affordable airspace modernisation approach for smaller aerodromes that have less air traffic control technology and equipment where space-based augmentation is available
- provide an alternative to non-precision approaches that is safer and more efficient
- provide a back-up to current precision landing systems to enhance resilience.

3.43 The use of spectrally efficient ground-based navigation systems will continue to ensure a robust and resilient navigation service remains, and will mitigate the

vulnerabilities of satellite navigation and support suitable area-navigation deployments.

Surveillance

3.44 Surveillance provides users with knowledge of 'who' is 'where' and 'when'. The application of space-based navigation and improved communication links will allow users to transmit positional information of necessary integrity both to airborne users, to enable 'detect and avoid', and to air navigation service providers, increasing both ground and airborne situational awareness. It is recognised that a primary surveillance capability (i.e. traditional non-cooperative radars[52]) will be required for the foreseeable future in support of the UK's defence and security objectives. However, there are opportunities that allow for the phased modernisation of the UK's surveillance capability, including:

- the greater uptake of aircraft broadcast position information and the advancements in available portable technology, allowing an affordable option for all aircraft operators (civil, military and General Aviation) to share electronic surveillance information about one another with one another
- the use of electronic conspicuity in provision of surveillance service by Flight Information Service Officers (FISO), enabling safe integration of approach operations at smaller General Aviation aerodromes
- new technologies and equipment for air traffic services to gather, process and display aircraft position information from multiple sources thus enabling the safe integration of a mix of airspace users
- deployment of an interoperable conspicuity solution and the associated ground use of the data to support air traffic services.

3.45 The aim is to develop solutions that enhance, harmonise and integrate cooperative and emerging non-cooperative sensors, advanced multi-sensor data fusion capabilities and security-related functionalities, together with the methods and tools for surveillance performance monitoring. This is in line with a performance-based surveillance (PBS) approach. In the integrated CNS solution, all CNS developments will be benchmarked and aligned in order to ensure that the solutions are consistent in terms of:

- robustness
- spectrum use
- interoperability
- operational service quality for all airspace users.

[52] Radar which can detect aircraft regardless of their equipment.

Air traffic management systems, tools and procedures

3.46 The modernisation of air traffic management systems, tools and procedures will provide stakeholders with more accurate and joined-up information about when flights plan to depart, when they do depart, the routes that they are expected to follow and when they are expected to arrive in particular sectors of airspace. The sharing of accurate and up-to-date flight information between air traffic controllers, network planners, flight crews and other operational stakeholders allows traffic flows to be sequenced and deconflicted earlier. Crossing traffic can be identified and resolved before the tactical interactions that characterise air traffic management today occur. This increases the options available to operational stakeholders and improves the management of network performance – increasing airspace capacity, safety, efficiency and resilience.

3.47 This modernisation is consequently a key enabler for:

- integration of new and existing users into UK airspace
- the effective integration of UK airspace with the wider European and global air transport network, allowing air traffic controllers to manage a larger number of flights through the same volumes of airspace with greater efficiency, resilience and flexibility.

Spectrum

3.48 Radio-frequency spectrum is an asset in high demand, mainly due to increased usage from the telecoms industry. The growing volume of data required to be transferred between aircraft (including drones and spacecraft) and air traffic services in order to facilitate the evolution of airspace management places greater pressure on the radio-frequency spectrum currently allocated to aeronautical services. A cross-industry plan for the efficient use of radio-frequency spectrum and the potential implications and possibilities of new mobile data spectrum is therefore required. This will ensure that aviation needs are understood, justified and reflect a real-time requirement for safe air operations that can contribute to the ambition of an integrated airspace. The rationalisation of the current ground infrastructure will enable the deployment of additional spectrally efficient systems that can support the expected increase in data traffic.

GNSS resilience

3.49 Because of the increasing use and reliance on space-based systems for Position Navigation and Timing (PNT), Initiative 14 in the 2018 AMS concerned the implementation of satellite navigation with the retention of sufficient ground navigation aids, communications and surveillance capability to ensure the continued provision of air services in the event of GNSS loss. Increasing reliance on GNSS makes this one of the key air traffic management security issues.

Transformation

3.50 In this rapidly changing landscape, the air navigation system must be transformed to address imminent challenges. Transformation is not an end goal in itself; rather, it is the way to achieve the AMS vision, the ultimate goal of which is to deliver a high-performing air navigation system, based on the ICAO GANP. The aviation industry needs to ensure its position at the forefront of innovation by adopting an increasingly cross-domain and global perspective.

3.51 Modernising and building necessary infrastructure within the air navigation system to generate new services and optimise current services is essential to accommodate growing demand and meet the requirements of existing and new users.

3.52 Innovations are required that meet unique situational demands, which the air navigation system as currently designed and anticipated cannot address, to obtain novel information that currently does not exist. Fostered by technology, increased automation in the air navigation system will:

- provide operators with enhanced functionality to enable better complex decision-making as well as reducing some repetitive operational tasks
- interact more collaboratively with operators, enabling the human and machine to function as a team to achieve operational work goals
- analyse large amounts of information presented in new ways, to support human decision-making and understanding, and
- enable all of the above to be undertaken when the technology and operator are geographically separated from each other.

3.53 Digital transformation and increased automation will require a parallel and structured approach that gives due consideration to the role of the human and the human-machine interface. The aim should be to make optimal use of human strengths and the capacity of humans to control tools while using the support of machines to manage situations, including those which are unexpected, quickly and safely.

Emerging, new and adapted business models

3.54 The transformational change in the aviation sector must be business-oriented and an enabler of new markets, as well as responsible in terms of global harmonisation and interoperability. Business decisions must support cross-industry operational requirements and the needs of customers.

3.55 Regulators such as the CAA continue to play an important role, but this role needs to evolve. Our strategy is that the UK has a regulatory framework that facilitates and encourages innovation, meets performance requirements and

supports the evolution of the air navigation system, while providing for monitoring and oversight.

3.56 States remain responsible for the regulations and services in the airspace under their responsibility. The UK must ensure that its regulatory processes support B2B (business to business) and/or B2C (business to consumer) approaches, specifically by allowing more options for service provision and enhancing the quality of services. Aviation is a global business and should deliver a consistent quality of service at a global level.

3.57 Because of the critical factor of aviation safety, the pace and uptake of innovation can be slower than desired. However, the aviation industry is beginning to look at other industries for emerging technologies that may be applied to aviation. These tried and tested technologies have the potential to reduce innovation life cycles and accelerate change in aviation, while ensuring that the net cost per consumer remains steady or is reduced. It is also possible to speed up change by including early-stage research, industrial research and development, and implementation experiences within the innovation life cycle.

3.58 An aviation system that is at the forefront of innovation, and that actively addresses cybersecurity and ensures adequate integration of military requirements, needs to be capable of providing suitable and timely responses to threats and attacks. The system must be capable of maximising human capacity and strongly supported by technology. Since aviation consists of a system where the servicing of mobile assets (including commercial aircraft, General Aviation, space launch vehicles and remotely piloted or autonomous air systems) is the primary objective, ensuring the integrity of all information is of utmost importance. Embracing mainstream information and network technology can lead to a more cost-effective and rapid modernisation of the aviation system.

Chapter 4

Overview of AMS delivery elements

Chapter summary

- This chapter gives an overview of the delivery elements that structure the delivery plans set out in Parts 2 and 3 of the AMS.
- There are nine elements arranged under two headings: aircraft-based navigation and airspace management. The 15 initiatives from the 2018 AMS, delivery of which will continue, are subsumed into these nine elements.

4.1 For the purposes of the AMS and the delivery plans that are set out in more detail in AMS Parts 2 and 3, we have grouped the 'ways' of modernising airspace into individual delivery elements under two headings:

- **aircraft-based navigation**
- **airspace management**.

4.2 There are nine elements under these two headings, as shown in Table 4.1, derived from the ICAO GANP Aviation System Block Upgrades (ASBU) framework (described in Chapter 3). The table also shows how each element relates to the 15 delivery initiatives set out in the 2018 AMS.[53] These initiatives will continue to be delivered as part of the new structure, as they are required stepping-stone elements to future ASBUs. (See paragraph 1.2 in Chapter 1 for an explanation of the broadened scope of the refreshed AMS.)

4.3 Tables 4.2 (aircraft-based navigation) and 4.3 (airspace management) show for each of the nine elements the individual related initiatives, and which of these are specific to the modernisation of UK airspace.

4.4 In preparing and maintaining the AMS, the CAA is bound by the legal and policy framework (see Appendix A), in particular section 70 of the Transport Act 2000, the Air Navigation Directions and the Air Navigation Guidance. We have noted in each table that all the delivery elements must adhere to the overarching principle of government policy on minimising the environmental impacts of aviation within

[53] The original 15 initiatives were based on European regulations that had direct legal effect in the UK and were in turn meeting the ASBUs. With the UK having now fully left the EU after the end of the UK/EU Agreement transitional period, from 31 December 2020 the UK law that applies is the retained EU Regulations, as amended by various UK Statutory Instruments (made under the European Union (Withdrawal) Act 2018). See Appendix A for more information.

the context of supporting a strong and sustainable aviation sector (in accordance with the Government's Air Navigation Guidance). Section 70 of the Act requires that maintaining a high standard of safety in the provision of air traffic services has priority over all other ends to be achieved by airspace modernisation.

4.5 Below Table 4.3, Figure 4.1 shows an overall summary of the delivery elements, aligned with the ICAO ASBU framework, in pursuit of the AMS strategic objectives.

Table 4.1: Structure for AMS delivery elements ('ways')

Category	2022 Elements	2018 AMS initiatives further developed through these elements	
Aircraft-Based Navigation	UK-ABN/1. Trajectory-based operations	2, 7, 8, 11, 14	Overarching principle: implementing government policy on minimising the environmental impacts of aviation within the context of supporting a strong and sustainable aviation sector
	UK-ABN/2. Terminal redesign	4, 5, 14	
	UK-ABN/3. Network management	3, 6	
	UK-ABN/4. Integration	3, 9, 10, 11	
Airspace Management	UK-AM/5. Airspace management		
	UK-AM/6. Data services	13, 15	
	UK-AM/7. Future surveillance and spectrum	11, 12	
	UK-AM/8. Integration of communications, navigation, surveillance & spectrum	12, 13, 14, 15	
	UK-AM/9. Aircraft capabilities	New	

Notes: Initiative 1 (Direct Route Airspace) in the 2018 AMS is complete.
More detail on specific elements UK-ABN/1 to /4 and UK-AM/5 to /9 is shown in Tables 4.2 and 4.3.

Table 4.2: Specific elements relating to Aircraft-Based Navigation

Category	Proposed 2022 AMS elements	Basis		Specific elements	
		GANP ASBU	National		
Aircraft-Based Navigation	1. Trajectory-based operations	✓		Further use of DCT (direct routeing) and FRA (free route airspace) leading to 4D trajectories	Overarching principle: implementing government policy on minimising the environmental impacts of aviation within the context of supporting a strong and sustainable aviation sector
				PBN (performance-based navigation) in support of the European route network	
	2. Terminal redesign	✓	✓	Noise respite – PBN (performance-based navigation) dispersal vs concentration; vertical profiles – developing a 'playbook' of procedure options	
		✓	✓	PBN (performance-based navigation) procedures to ensure the right-sized controlled airspace providing suitable containment	
		✓	✓	Develop airspace sharing (flexible access)	
		✓	✓	Net Zero/Jet Zero targets	
		✓	✓	FASI programme (Future Airspace Strategy Implementation) through the airspace change masterplan coordinated by ACOG (Airspace Change Organising Group)	
	3. Network management	✓		Queue management (arrival and departure management)	
	4. Integration	✓	✓	Lower airspace flexible access (airspace switched on when required)	
		✓	✓	Access for drones (BVLOS – beyond visual line of sight), advanced air mobility, high-altitude platform systems (HAPS) and space	
		✓		AFUA (Advanced Flexible Use Airspace)	

Table 4.3: Specific elements relating to Airspace Management

Category	Proposed 2022 AMS elements	Basis		Specific elements	
		GANP ASBU	National		
Airspace Management	5. Airspace management	✓	✓	Air and space management – traffic management system for the UK combining ATM (air traffic management), UTM (UAS Traffic Management) and developing procedures for space activity	Overarching principle: implementing government policy on minimising the environmental impacts of aviation within the context of supporting a strong and sustainable aviation sector
		✓	✓	New Lower Airspace Service – replace LARS (Lower Airspace Radar Service) and London/Scottish Information Service with a bespoke, surveillance-based flight information service. *Planned to be service delivery and enabler for flexible access to airspace – intermediate service until technology and equipment update allows autonomous flight*	
		✓	✓	Airspace Management Cell – lower airspace management through Lower Airspace Service aligned with existing Airspace Management Cell	
			✓	Air traffic service use of electronic conspicuity information for service provision and airspace management	
	6. Data services	✓		SWIM (System-Wide Information Management) enabling 'the one truth' (AIM/MET/NOTAM etc) and cyber considerations	
		✓		Autonomous flight and remotely piloted aircraft systems	
	7. Future surveillance and spectrum	✓	✓	Cooperative surveillance including low-cost solutions	
		✓	✓	Spectrum management and spectrum interference	
				Security needs – cyber, GNSS (global navigation satellite system) resilience	
		✓	✓	Datalink applications	
		✓	✓	Long-term future surveillance (ground- and space-based)	
				continued overleaf	

Table 4.3: Specific Elements relating to Airspace Management (continued)

Category	Proposed 2022 AMS elements	Basis		Specific elements	
		GANP ASBU	National		
Airspace Management (continued)	8. Integration of communications, navigation, surveillance & spectrum	✓	✓	Modernisation of Communications, Navigation and Surveillance (CNS) infrastructure to support the migration to space-based technology and provide contingency through multi-frequency multi-constellation capabilities as well as A-PNT and a core ground-based infrastructure to provide resilience across CNS	Overarching principle: implementing government policy on minimising the environmental impacts of aviation within the context of supporting a strong and sustainable aviation sector
			✓	UK Space-Based Augmentation System initiative	
	9. Aircraft capabilities		✓	Electronic conspicuity on aircraft <5700kg (including drones, advanced air mobility and high-altitude platform systems)	
		✓	✓	Airborne collision avoidance system updates to integrate electronic conspicuity data	
		✓	✓	MFMC (multi-frequency multi-constellation) capabilities	
		✓	✓	Datalink equipage	
		✓	✓	Performance-based navigation capabilities	

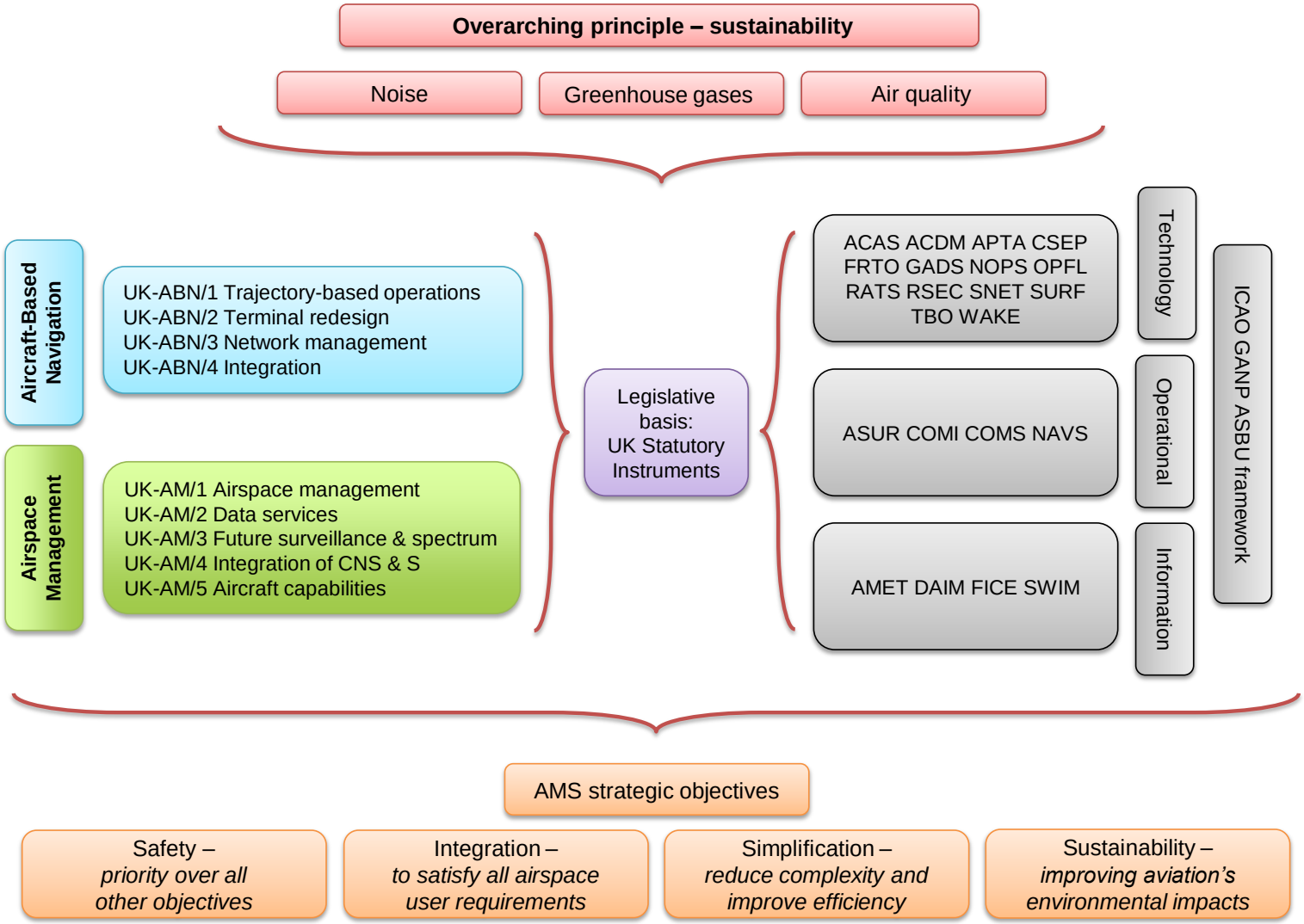


Figure 4.1: Overall summary of the delivery elements aligned with the ICAO GANP ASBU framework in pursuit of the AMS strategic objectives

Chapter 5

Use cases – a vision of airspace in the 2030s

Chapter summary

The UK has a limited airspace volume in which to integrate current and new user ambitions. Integration of users in the lower volumes of airspace is a key challenge. It requires significant change in the way we define and manage the operational use of such airspace. The changes required are wide-ranging and will require new and innovative methods of developing and deploying solutions.

This chapter describes five illustrative use cases relating to different aspects of modernised airspace from the perspective of different stakeholders:

- 1. The future structure of airspace
- 2. Air traffic service provision
- 3. Remotely piloted aircraft systems
- 4. Spacecraft (ground- or air-launched)
- 5. Recreational General Aviation flight between two small airfields in class G airspace

Acronyms in the use cases

Below are the acronyms from the use cases which for space reasons we were unable to set out in full. For more information please see the glossary at Appendix B.

AFISO Aerodrome flight information service officer	**AFUA** Advanced flexible use of airspace
A/G air ground	**AIP** Aeronautical information publication
ATC air traffic control	**ATCS** Air traffic control service
ATM air traffic management	**ATS** Air traffic service
ATZ Aerodrome traffic zones	**BVLOS/LOS** Beyond visual line of sight/line of sight
CTA Control area	**CTR** Control zone
DATIS Data link-automatic terminal information service	**FIR** Flight information region
FIS Flight information service	**FIS-B/TIS-B** Flight/traffic information service – broadcast
FL Flight level	**FRZ** Flight restriction zone
GNSS Global navigation satellite system	**ICAO** International Civil Aviation Organization
IFR Instrument flight rules	**IMC** Instrument meteorological conditions
METAR Meteorological terminal air report	**NOTAM** Notice to air missions
PANS Procedures for air navigation	**PBN** Performance-based navigation
RA(T) Restricted area (temporary)	**RMZ** Radio mandatory zone
SARP Standards and recommended practices	**SIGMET** Significant meteorological information
SWIM System-wide information management	**TAF** Terminal aerodrome forecast
TMA Terminal manoeuvring area	**TMZ** Transponder mandatory zone
TMZ(T) Transponder mandatory zone (temporary)	**UAS** Unmanned aircraft system (drones)
UIR Upper flight information region	**UTM** UAS traffic management
VFR Visual flight rules	**VMC** Visual meteorological conditions
VOLMET Metereological information for aircraft in flight	

Use case 1: The future structure of airspace

Type of airspace	Future structure of airspace vision
General	Although autonomous operations in UK airspace are a long-term aspiration, the UK will remain subject to ICAO airspace classifications for the time being. During this period, the aim is to develop UK airspace to allow wider access across all existing and future airspace users. In the interim, we will need to develop UK airspace such that it will, where possible, enable increased access for all existing and future airspace users. There will be an intent to remove long periods of segregation in favour of 'switching on' airspace for a specific activity. For example, a Control Zone/Area around an airport should only be active at a higher classification when the unit is providing an air traffic control service to Instrument Flight Rules (IFR) arriving and departing traffic. To enable tactical freedom where required (such as Ministry of Defence units), when the classification downgrades, the airspace reverts to TMZ/RMZ (transponder mandatory zone/radio mandatory zone). (See Figures 5.1 and 5.2 below.) An Air Traffic Zone (ATZ) for ATCS provision to Visual Flight Rules (VFR) traffic may be created but will be based upon traffic density/complexity at the aerodrome and not the licensed status. The introduction of CAA-regulated intensity-based minimum classification allocation i.e. class C at the busiest airports, to allow VFR and IFR to be separated. Reduction of class A. Airspace above FL95 to become class C to enable Free Route and Trajectory Navigation with suitable airspace management processes in place, like Advanced Flexible Use of Airspace, to enable de-classification of areas for military activity and specific aviation sport and leisure activity, such as high-flying glider activity. Increased use of class E with a TMZ in other areas to enable ATC provision to IFR while minimising impact to VFR. AFIS/Air Ground airfields will have a flexible TMZ/RMZ and RMZ respectively. For an AFIS unit this will allow the use of Flight Information Displays (FID) to be used to enable better airspace management and safety. The TMZ can also be an aid to integration of IFR and VFR traffic if GNSS approaches are being used. Around busy AG units, a RMZ will be used to provide a level of safety for aircraft in the critical stages of flight. When the airfield is closed or traffic minimal, the airspace can be switched off. There will remain some segregation around activities such as certain military activities and space launches as well as the requirement for Restricted/Prohibited areas. Airspace establishment, disestablishment and classification should always be related to demonstrable utilisation and complexity criteria, and subject to routine review. A clear containment policy relating to the activity and route structure to be contained within any classification of airspace should determine the size and shape of that airspace. Performance-based navigation (PBN) is an important element that provides highly accurate and repeatable flightpaths, reducing the need for large areas of containment through the use of controlled airspace. Integration of new airspace users such as BVLOS (beyond visual line of sight) drone and advanced air mobility operations will normally be accommodated within the airspace classification. It will utilise an overlay of air traffic services where additional information services are provided to achieve safe integration, rather than being segregated from other airspace users. The need for airspace segregation will remain for some activities, such as certain military operations and space launch. [Continued overleaf]

Use case 1: The future structure of airspace (continued)

Type of airspace	Future structure of airspace vision
Class A	Where the complexity of the air traffic management task justifies a permanent IFR-only environment, and where no reliance can be placed upon the ability of VFR flights to see and avoid other airspace users.
Class C	The UK FIRs and UIRs between FL 195 and FL 660 are notified as airspace class C. The lower limit may be dropped to FL 95 to allow for free route and trajectory navigation. An airspace management process (such as Advanced Flexible Use of Airspace) will enable access to, for example, military operations or sports and leisure flights (such as gliders). Within the UK FIRs below FL195, class C may be notified for CTAs, airways (or portions thereof) and TMAs (or portions thereof). It is an aspiration of the CAA for current class D airways to be progressively notified where appropriate as class C, where this reflects actual operational conditions associated with each of the airways in question, and in accordance with principles outlined above. Class C should be notified for CTRs and CTAs in the vicinity of major international aerodromes as determined by the type, density and complexity of air traffic (including a consideration of forecast air traffic volumes) and particularly the volume of IFR flights.
Class D	Class D is normally notified for CTRs and CTAs in the vicinity of those aerodromes where an ATC service is provided to aerodrome traffic, except where the design principles identified by the airspace change sponsor identify the need for a more restrictive classification. Class D airspace is notified for locations where a known traffic environment is necessary in both visual meteorological conditions (VMC) and instrument meteorological conditions (IMC). Exceptionally, within the UK FIRs below FL195, class D may also be notified for TMAs (or portions thereof) and for certain airways (or portions thereof). A relatively small volume of class D airspace may be used in lieu of Aerodrome Traffic Zones at aerodromes where an ATC service is provided. Class D CTRs and CTAs will be subject to Advanced Flexible Use of Airspace principles when such airspace is not required to support IFR operations.
Class E	Class E is to be notified where a known recognised air traffic picture is necessary only for low complexity and/or low density IFR flights. Class E may be notified for certain airways (or portions thereof), or for CTA in the vicinity of certain aerodromes where an air traffic control service is provided to aerodrome traffic but where airspace classes A to D cannot be justified. Class E shall not be used for CTRs. Class E airspace will normally be collocated with a TMZ to enable the additional safety net of a detectable traffic environment and allowing cooperative surveillance services to be used in the management of such airspace.
Class G	This airspace classification applies to the remainder of the UK FIRs. [Continued overleaf]

Use case 1: The future structure of airspace (continued)

Type of airspace	Future structure of airspace vision
Radio Mandatory Zone / Transponder Mandatory Zone (RMZ/TMZ)	Enhancements to the characteristics of airspace classes D, E, F and G, such as the additional notification of the airspace as a transponder and/or radio mandatory zone (TMZ and RMZ respectively) should be considered in order to: • meet safety criteria identified by the air navigation service provider in their safety assessment • facilitate the provision of flight information, alerting and search and rescue services (applies to RMZ only) • facilitate the provision of enhanced flight information utilising surveillance data, (applies to TMZ only), and • facilitate coordination with appropriate military units or with ATS units in adjacent States in order to avoid the possible need for interception for the purpose of identification. Aerodrome Traffic Zones in class G airspace will typically be replaced by an RMZ (related to traffic density and complexity rather than licensed status of the aerodrome) and associated TMZ where enhanced flight information utilising surveillance data is deployed, typically in support of low density, low complexity IFR operations such as GNSS approaches. Radio Mandatory Zones established at aerodromes and serviced via an Air/Ground service will only be established when that service is provided. The switchable nature of such RMZs will be embedded in Advanced Flexible Use of Airspace procedures.
Air traffic services where additional information services are provided	Enhancements to the characteristics of all airspace classes in support of BVLOS drone and advanced air mobility operations.

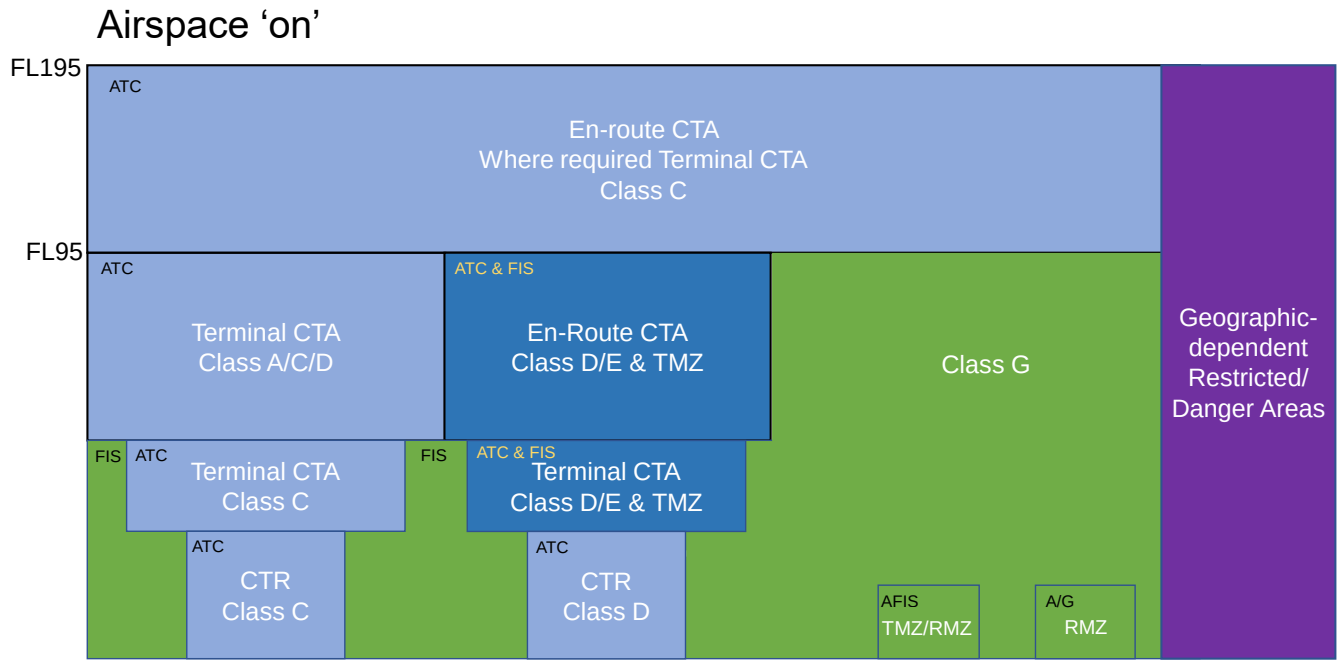


Figure 5.1 Future airspace structure concept (cross-section) – airspace 'on'

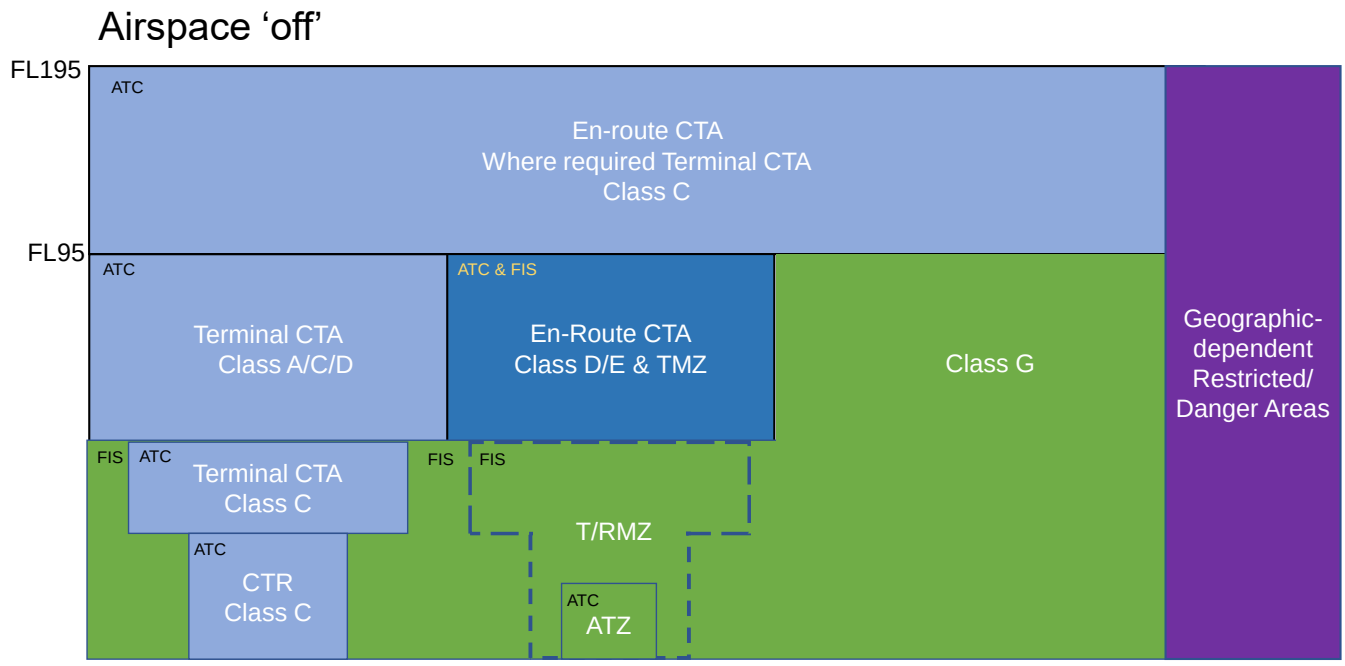


Figure 5.2 Future airspace structure concept (cross-section) – airspace 'off'

Use case 2: Air Traffic Service provision

Type of service/ operation	Future Air Traffic Service vision
General	Traffic management and services provided will be inclusive of both existing users and new entrants such as drones and spacecraft.
Conventional ATS	Aligned with ICAO Standard and Recommended Practices (SARPs) and Procedures for Air Navigation (PANS), hence air traffic control service provided only in controlled airspace with ICAO Flight Information Service (FIS) outside of controlled airspace, when not co-provided with an air traffic control service. Supplemented by data services providing FIS including airspace information and other platform activity through connected onboard SWIM-profiled systems such as FIS-B/ TIS-B.
Drone and advanced air mobility	Service provision to support BVLOS (beyond visual line of sight) drones and advanced air mobility will form an element of air traffic management (ATM) and the additions to ATM in support are likely to be prescribed enhancements to ICAO FIS provision within a defined volume of airspace. This service will be provided by an air navigation service provider, who may be the operator of the BVLOS platform, but more likely to be an (existing or new) air navigation service provider who is capable of servicing BVLOS ATM/UTM (UAS Traffic Management) requirements in class G and above.
UK Flight Information Service (FIS) Lower Airspace Radar Service (LARS)	Replaced with ICAO FIS. Will be common to the service provided in mainland Europe. Replaced by bespoke lower airspace service which will: • be provided 24/7, concentrated in daylight hours • enable flexible access • act as lower airspace management cell • enable airspace crossing or access • act as UAS Traffic Management (UTM) conduit • act as a technology conduit to autonomous airspace – stepping-stone taking into account aircraft capability and technology advances necessary for full autonomy • use cooperative surveillance to provide safe and efficient FIS (traffic information and where necessary deconfliction advice – not separation)

Use case 3: Remotely piloted aircraft systems

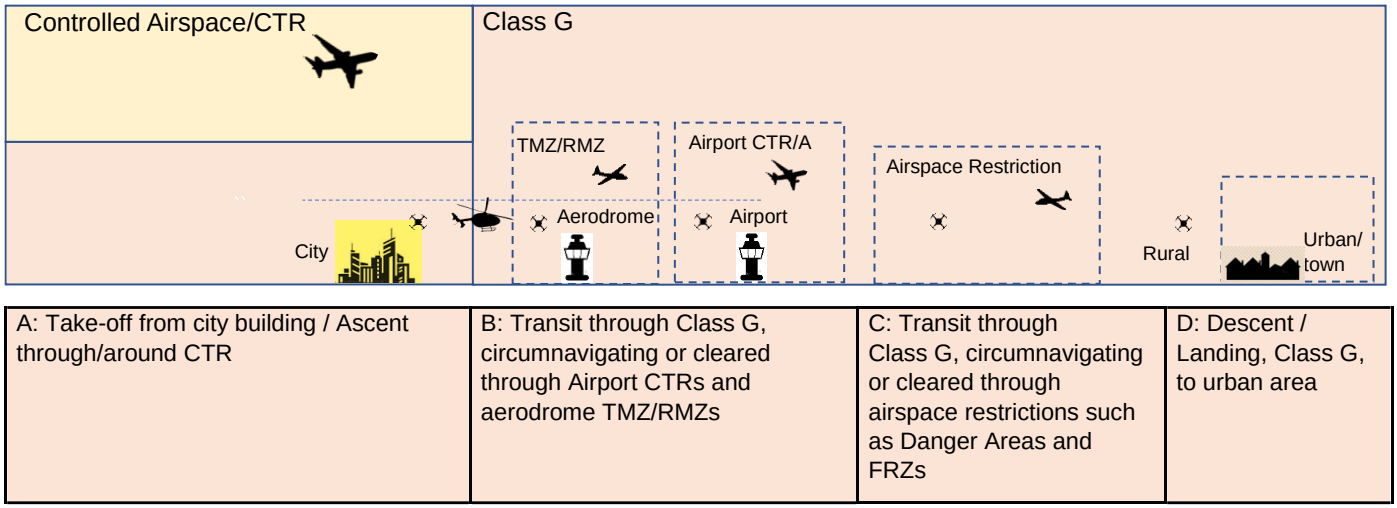
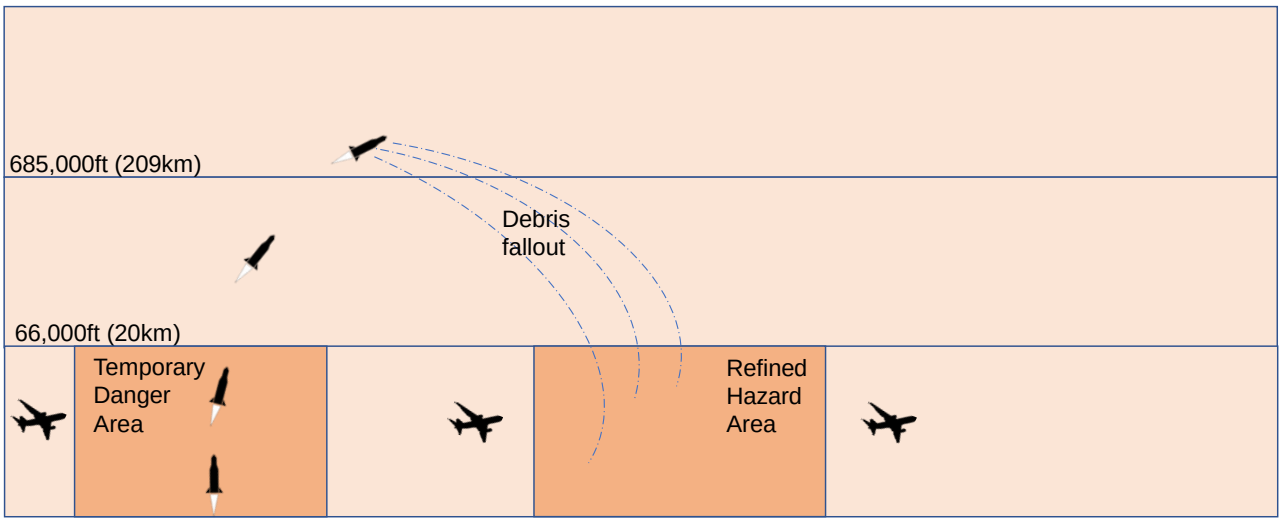


Figure 5.3 Future airspace structure concept – remotely piloted aircraft systems

Phase of flight	Future Air Traffic Service vision
Prior to flight	The UAS operator will pre-notify its planned activity using a SWIM-connected airspace management tool. This will inform the UAS operator of other activity planned in the proposed operating area, airspace restrictions and other information relating to the flight, such as weather. This pre-notification would also be used to initiate clearances, such as being able to operate within controlled airspace or flight restriction zones etc. This information will then also be available to other airspace users, airspace control authorities and other interested parties. Pre-notification will apply to both beyond visual line of sight (BVLOS) and line of sight (LOS) UAS flights to give a complete picture of activity to all operators.
Airborne	Once airborne the UAS platform will operate as planned. Re-tasking and changes will be allowed within uncontrolled airspace and the SWIM-enabled airspace management system can be updated as required. Electronic conspicuity will be required to enable ‘detect and avoid’ for all airspace users, thus reducing the risk of mid-air collisions.
Clearances	Before crossing airspace, the operator will need clearance to enter. Having been pre-notified to the airspace management system, the flight will be visible to the airspace controlling authority, allowing appropriate clearances to be provided. From the operator’s perspective, the activity status of the airspace will be provided both pre-flight and en route, allowing early re-routeing of the flight if clearance is likely to be refused. This would also be the case for other airspace restrictions such as danger areas, flight restriction zones etc. For routine flights, such as advanced air mobility routes in and out of airports, delivery services or airfield security, clearances may be secured through prior written agreement.

Use case 4: Spacecraft (ground- or air-launched)



A. Temporary Danger Area activated and notified to both airspace control authorities and aircraft operators in near real-time for launch	B. Temporary Danger Area deactivated C. On-trajectory explosion 569secs after launch	C. Refined Hazard Area determined, created and notified based on debris fallout	D. Refined Hazard Area deactivated and normal aviation operations resume

Figure 5.4 Future airspace structure concept – space launch

Future Air Traffic Service vision
The long-term aspiration for airspace requirements for space launch is to use a concept based around dynamically used airspace, i.e. airspace which is tied to the platform rather than a location. This way when the platform launches, regardless of whether it is ground- or air-launched, a dynamic volume of airspace could be managed to protect other airspace users from rocket flight, falling spent stages or falling debris from an unplanned event. In practice this airspace activity data would be shared with other airspace users through an airspace management function on SWIM profiles. As with other scenarios, this will allow other airspace users to see real-time airspace availability. The full detail of what this airspace will look like is still to be determined as UK spaceflight continues to develop. In the interim, methods of reporting this activity will be through the future Lower Airspace Service, combining the use of technology solutions such as FIS/TIS-B and traditional voice. It is unlikely that space launches will reach the level of commercial flights in the timescale of this AMS. Therefore, early notification of intended airspace requirements would be planned through mission trajectory planning software, operating across SWIM profiles. The benefit of using the mission trajectory is that it will allow the operator to request the airspace with sufficient advance notification, like other airspace requests. As the launch date gets closer, the activation time will be firmed up and updated once the carrier platform gets airborne. Other airspace users utilising trajectory navigation would receive the notification in plenty of time to ensure minimal if any disruption to their planned routes.

Use case 5: Recreational General Aviation flight between two small airfields in class G airspace

Future structure of airspace vision
Sports, recreational and private transport General Aviation often operates from private grass (unlicensed) airfields with a varying number of movements and activity types. These airfields are typically located within class G airspace but may be notified, should the owner request, via the sharing of data to electronic flight bag providers and additionally centrally correlated via AIP (Aeronautical Information Publication) submission, regardless of their licensed status. The airspace immediately surrounding an airfield engaging in high-intensity General Aviation operations and/or training operations, may be afforded the protection of a Radio Mandatory Zone in lieu of the current Aerodrome Traffic Zone. Additionally, those typically situated within class G airspace and supporting frequent IFR operations including GNSS approaches may additionally be protected by a Transponder Mandatory Zone when the Flight Information Service provision at that airfield, air traffic control or Aerodrome Flight Information Service Officer (AFISO), is supplemented by cooperative surveillance data. Increasingly, switchable volumes of airspace, such as runway-dependent control areas (CTAs), will be temporarily deactivated when not required (possibly with a Transponder Mandatory Zone/Radio Mandatory Zone mandate associated), allowing transit without the necessity of a clearance. The tactical notification of this kind of airspace release will be achieved via NOTAM, generating a graphical depiction on avionics/electronic flight bag applications as well FIS-B (Flight Information Service – Broadcast).

Phase of flight	**Future Air Traffic Service vision**
Prior to flight	Pre-flight planning by the pilot will typically be conducted using an ‘electronic flight bag’ application connected to the internet. The application graphically depicts the current relevant aviation chart together with tactically updated airspace and meteorological information, including dynamically switched airspace volumes, temporary navigation warnings etc. Having planned the intended flight, the pilot can, via the electronic submission of the data, share that flight plan with air traffic service providers and other airspace users. This flight plan data will be transmitted in a common, internationally agreed, format and distributed to any relevant party that wishes to make use of the data. Route field validation of VFR flight plans will be achieved via a prescribed interface typically enabled via the electronic flight bag functionality. Once airborne, the activation and correlation of the planned intention of flight data will typically be achieved via the association with the flight identification field transmitted from the airframe. When, via route validation, if the planned route will require the subject aircraft to transit a volume of controlled airspace then that flight plan will be automatically shared with the controlling authority of that airspace. Flight data processing systems used by air navigation service providers will be capable of receiving and pre-notifying the relevant controller or Flight Information Service Officer of the pending flight details together with the planned track. [Continued overleaf]

Use case 5: Recreational General Aviation flight between two small airfields in class G airspace (continued)

Phase of flight	Future Air Traffic Service vision
Airborne	Once airborne, the General Aviation pilot may choose to take advantage of a revised UK Flight Information Service (FIS) based upon an ICAO-prescribed FIS with or without surveillance data enhancement. This service may be manually requested via radio contact with a nominated air navigation service provider; the service itself will instantly be recognisable as FIS provision like that provided in other states. Increasingly, FIS provision will be automated, with situational awareness within the cockpit being enhanced via directly detected traffic information and conflict prediction, displayed via an electronic flight bag application or avionics display. FIS-B will be available in many areas, in lieu of VOLMET and some DATIS capability, and will include a wide range of meteorological products (including near-real-time precipitation data, METARs, TAFs, SIGMETs) as well as selected 'pop-up' NOTAM information such as RA(T)s, TMZ(T)s and the activity status of any switchable airspace volumes. FIS provision, situational awareness and safety will be additionally enhanced by the tactical switching of electronic Obstruction Beacons on the ground. These electronic beacons will be used to notify the activation of cluster-based activities such as large model sites, paragliding and hang-gliding activity, where electronic conspicuity of individual air systems is not practicable or desirable. The emissions from these beacons can be received via the reception of a broadcast in the cockpit and depicted on existing avionics or electronic flight bag applications. En route transit requests of controlled airspace will have been pre-notified to the controlling air navigation service providers via the voluntary submission of the flight plan. Those basic flight details and requested routeing will be available to the controller prior to establishing radio contact and may also be associated with the flight identity of the aircraft on a suitable surveillance system. The necessity of passing copious amounts of flight planning information over the radio is reduced and the ability for the controller to plan the integration of the transiting aircraft enhanced.
Arrival	Upon arrival at the destination at a General Aviation airfield in class G airspace serviced by air traffic control or Aerodrome Flight Information Service Officer (AFISO), the Flight Information Service provided to the pilot is enhanced by the use of cooperative surveillance data and provided to the pilot via relay of surveillance-based traffic information.

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Chapter 6
Funding

Chapter summary

This chapter explains:

- that aviation, and therefore airspace modernisation, is almost entirely funded by the aviation industry
- certain AMS deliverables that may benefit from schemes funded by government or industry
- the uncertainty over the source for funding some aspects of modernisation, in particular lower airspace and the integration of existing airspace users and new types of user.

Overview

6.1 Aviation in the UK is largely privately owned and managed, and therefore the investment required to upgrade UK airspace is almost entirely funded by the aviation industry. This is known as the user-pays principle.

6.2 In the case of NERL, the costs of providing monopoly en route (and certain approach) air traffic services and airspace management are recovered from the UK overflight charging mechanism (the en route rate), and thus from those airspace users paying en route charges. (Each EUROCONTROL member state establishes the unit rate of en route charges levied on airspace users in the airspace for which it is responsible.) For other aspects of airspace modernisation, in particular integration of existing and new airspace users at lower levels, the means of financing the changes necessary is less clear.

AMS Support Fund

6.3 Delivery of the AMS requires industry or other interested organisations to undertake supporting delivery or engagement work that benefits multiple stakeholders or research that will enable wider industry deployment. Where the modernisation cannot be funded by other means it may require a level of financial support to facilitate that delivery. For this purpose the CAA has set up

the AMS Support Fund.[54] The fund follows on from the Future Airspace Strategy (FAS) Facilitation Fund (specifically the Small Gaps element) that ran from 2015 to 2019.

6.4 The dedicated fund (currently £2 million per annum) is funded through the UK en route unit rate. It was established as part of the UK RP3 performance plan, and we expect provision to continue in the new UK performance plan that supersedes RP3 covering the period 2023 to 2027, known as NR23. The fund will be collected through the CAA element of the en route unit rate and administered by the CAA. Any unutilised funds will be returned to airlines through an adjustment to the UK unit rate in a future regulatory period.

Financing other aspects of modernisation

6.5 To the extent that delivering a modernised airspace requires investment in new technology, or a new service, an issue arises as to how those costs are recovered and who pays. In certain circumstances there may be a case for central funding from government or the industry generally. Two examples are given below.

Electronic conspicuity devices

6.6 To encourage greater take-up of electronic conspicuity devices within the General Aviation and remotely piloted aircraft system communities, the Department of Transport made available a funding scheme in the form of a 50% rebate of up to £250 (including VAT) per applicant.[55]

Future Airspace Strategy Implementation (FASI) Grant Programme Funding Support Package

6.7 This funding was in the extraordinary circumstances of the Covid-19 pandemic. Following the collapse of air travel during the pandemic, the Department for Transport and CAA confirmed a continued commitment to airspace modernisation and the need to consider how individual organisations might progress airspace change.[56] As part of a commitment to supporting restart in the aviation sector and decarbonisation, and in response to a recommendation in the Airspace Change Organising Group's July 2020 report on remobilising the airspace change programme[57], the Government announced a £5.5m financial

54 https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/Airspace-Modernisation-Strategy-Support-Fund/

55 https://www.caa.co.uk/General-aviation/Aircraft-ownership-and-maintenance/Electronic-Conspicuity-devices/

56 https://www.gov.uk/government/publications/update-on-airspace-modernisation/dft-and-caa-update-on-airspace-modernisation-march-2021

57 https://www.acog.aero/blog/2020/07/17/acog-remobilising-airspace-change-report/

support package.[58] This took the form of a grant managed by the CAA to enable eligible sponsors of airspace change to continue through Stage 2 of the airspace change process.

Future funding models

6.8 The CAA recognises that there has to be a fair and equitable funding model for users of a modernised airspace. Currently, aside from the UK Flight Information Service provided to meet ICAO obligations and specific arrangements for the North Sea, aircraft outside controlled airspace are either not receiving a service (relying on a traditional 'see and avoid' means of deconfliction) or are benefiting from navigation aids and/or air traffic services that are already established for commercial or military users.

6.9 We will address questions on how to finance the support and implementation of modernisation such as (a) a future Lower Airspace Service (b) integration of new types of aerial vehicle (c) greater access to airspace for recreational General Aviation. We would expect to consult on this in due course, subject to advice from the Government.

[58] https://www.gov.uk/government/news/55-million-to-drive-improvements-to-uks-motorways-in-the-sky

APPENDIX A

Legal and policy framework

Summary

This appendix explains:

- the UK legal and policy framework underpinning airspace modernisation
- how this governs alignment of the AMS with the ICAO GANP and UK-specific requirements
- key developments in airspace policy in recent years illustrating the direction of travel, what we know of emerging policy, and where there may be gaps.

Overview

A1. The CAA's function is to prepare and maintain this AMS within the legal and policy framework set by the Government, as summarised in this section. More information can be found on the CAA's website[59] or via the links at the end of this appendix and in the glossary in Appendix B.

A2. The CAA works closely with the Government to provide clarity around our respective policy and decision roles relating to airspace. As a regulator, the CAA is responsible for defining and setting policies relating to how it exercises its functions. The CAA is not responsible for developing or reviewing legislation and Government policy. The policy ultimately rests with our democratically elected Government.

A3. Where we believe there are opportunities for the legislation and policy framework to better support the carrying out of the CAA's functions, we will work with the Government to enhance our regulatory environment, where possible and appropriate, for the benefit of those that we regulate and wider society. For example, it may be that Government policy does not provide a clear solution to any trade-offs that arise between the delivery of airspace modernisation initiatives or the different airspace design changes identified in the forthcoming

[59] https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Legislative-framework-to-airspace-change/. Page 13 of CAP 1616 also explains the relationship between CAA guidance and government policy www.caa.co.uk/cap1616

airspace change masterplan. Should this occur, we may use our expertise to provide technical advice to assist the Government with possible trade-off policies to support CAA work on the delivery of the AMS, and ultimately seek such policy guidance from the Government.

A4. While this appendix summarises relevant legislation and policy, it is not intended to be exhaustive, nor should it be taken as the only legislation and policy the CAA considers when exercising its regulatory functions in relation to airspace modernisation.

A5. The CAA will keep the context for the AMS under review – including the legal and policy framework, for example the Government's Jet Zero strategy – and consider whether any changes to the AMS are needed.

The Civil Aviation Authority (Air Navigation) Directions 2017

A6. Referred to for convenience as the Air Navigation Directions, these give the CAA its functions in relation to air navigation, including to prepare and maintain the AMS. Among other things, the Air Navigation Directions also require the CAA to publish the UK airspace design; to approve changes to it or in some cases to the procedures for using it; to develop policy and strategy on the classification and use of airspace; to regularly review airspace classification and amend it as appropriate; and to develop and publish procedures and guidance on the development, making and consideration of airspace change proposals. All the CAA's responsibilities in the Air Navigation Directions must be carried out in compliance with the CAA's general duty under Section 70 of the Transport Act 2000.

A7. Specifically relating to the AMS, Direction 3 states, among other things, that the CAA must:

- (e) prepare and maintain a co-ordinated strategy and plan for the use of all UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace
- (f) consult the Secretary of State in relation to the preparation and maintenance of such strategy and the detail to be included in such plan, and
- (g) report to the Secretary of State annually on the delivery of the strategy referred to in sub-paragraph (e), the first such report to be provided by the end of 2018.

Transport Act 2000

A8. The CAA's statutory duties in respect of air navigation are contained in Chapter III of Part 1 of the Transport Act 2000 and The Civil Aviation Authority (Air Navigation) Directions 2017 (as amended).

A9. Section 70 of the Transport Act places the CAA under a general duty in relation to its air navigation functions to exercise those functions so as to maintain a high standard of safety in the provision of air traffic services. That duty is to have priority over the CAA's other duties in this area of work. Noting that priority, the CAA's duties in relation to air navigation is to exercise its functions in the manner it thinks best so that:

- it secures the most efficient use of airspace consistent with the safe operation of aircraft and the expeditious flow of air traffic
- it satisfies the requirements of operators and owners of all classes of aircraft
- it takes account of the interests of any person (other than an operator or owner) in relation to the use of any particular airspace or airspace generally
- it takes account of any guidance on environmental objectives given to the CAA by the Secretary of State
- it facilitates the integrated operation of air traffic services provided by or on behalf of the armed forces and other air traffic services
- it takes account of the interests of national security
- it takes account of any international obligations of the UK notified to the CAA by the Secretary of State.

A10. The CAA's air navigation functions are the functions which we are required to perform under the Air Navigation Directions.

A11. In respect of our strategic role, the strategic vision for airspace modernisation to 2040 as articulated at the beginning of this document is informed by the material factors in section 70 of the Transport Act 2000. In addition, these material factors inform the ends or policy objectives of a modernised airspace, as discussed in Chapter 2.

A12. If in a particular case there is a conflict in the application of the material factors in section 70, the CAA must apply them in the manner it thinks is reasonable having regard to them as a whole. The CAA must also exercise its air navigation functions so as to impose on providers of air traffic services the minimum restrictions which are consistent with the exercise of those functions.

A13. For more information on how the CAA interprets its statutory duty under section 70, see Appendix G of CAP 1616.[60]

Air Navigation Guidance 2017

A14. Section 70(2)(d) of the Transport Act 2000 requires the CAA to take account of any guidance on environmental objectives given to it by the Secretary of State when carrying out the air navigation functions set out in the Air Navigation Directions. This is subject to the CAA's primary duty of maintaining a high level of safety.

A15. The Air Navigation Guidance was last issued in October 2017[61] following a consultation by the Department for Transport about airspace and noise policy.[62] The Air Navigation Guidance is not just addressed to the CAA. The Government also expects that it will be taken into consideration by the aviation industry. The Air Navigation Guidance also acknowledges the important role which local communities have in the airspace change process.

A16. Underpinning the Air Navigation Guidance are a number of key overall objectives set by the Government. These include:

- to provide guidance to the CAA under section 70(2) of the Transport Act 2000 and which the aviation industry should take account of
- to ensure that aviation can continue to make its important contribution to the UK economy and at the same time seek to improve the sustainable development and efficiency of our airspace network
- to strengthen the UK's airspace change process and its transparency, particularly with respect to how local communities are involved within it, and
- to emphasise that the environmental impact of aviation must be mitigated as much as is practicable and realistic to do so.

60 CAP1616: *Airspace change: Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information.* www.caa.co.uk/cap1616

61 Air Navigation Guidance 2017: Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, Department for Transport October 2017. https://www.gov.uk/government/publications/uk-air-navigation-guidance-2017

62 *Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace,* Department for Transport October 2017. https://www.gov.uk/government/publications/uk-airspace-policy-a-framework-for-the-design-and-use-of-airspace

A17. The Air Navigation Guidance contains the Government's environmental objectives with respect to air navigation. These environmental objectives are designed to minimise the environmental impact of aviation within the context of supporting a strong and sustainable aviation sector. They are, in support of sustainable development:

- to limit and, where possible, reduce the number of people in the UK significantly affected by adverse impacts from aircraft noise
- to ensure that the aviation sector makes a significant and cost-effective contribution towards reducing global emissions, and
- to minimise local air quality emissions and in particular ensure that the UK complies with its international obligations on air quality.

A18. The Air Navigation Guidance recognises the degree of challenge which can exist in satisfying the expectations of local communities, those impacted by aviation, and the aviation industry's aspiration to further develop the efficiency of the UK airspace network. For example, a key policy issue is how to retain the benefits of aviation while addressing its environmental impacts, and how the CAA should integrate those considerations when making regulatory decisions on the necessary trade-offs between differing airspace objectives, such as increasing airspace capacity, reducing emissions and managing noise.

A19. Through the Air Navigation Guidance, the Government acknowledges that there are other legitimate operational objectives, such as the overriding need to maintain a high standard of safety, the desire for sustainable development, and the need to enhance the overall efficiency of the UK airspace network, which the CAA and others are required to take into account and consider alongside the environmental objectives of the Air Navigation Guidance.

A20. When devising this AMS, noting the overriding objective of safety, the CAA has applied the competing factors in section 70(2) in the manner it thinks is reasonable having regard to them as a whole.

Jet Zero strategy

A21. In July 2021 the Government published its Jet Zero consultation[63] which outlined its commitment for the aviation sector to reach net zero greenhouse gas emissions by 2050 and a proposed target for UK domestic aviation to reach net zero by 2040.

A22. The consultation outlines five core policy measures to achieve net zero aviation, including in-sector reductions such as system efficiencies, sustainable aviation

[63] *Jet Zero consultation: A consultation on our strategy for net zero aviation*, Department for Transport July 2021. https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050

fuel and zero-emission flight, and the development and implementation of carbon markets and greenhouse gas removal methods to offset residual emissions. The consultation proposes to set a CO_2 emissions reduction trajectory for aviation to 2050 against which the Government will monitor progress, with the strategy reviewed every five years and the approach updated if needed. The Government is expected to publish its Jet Zero strategy in 2022 following a review of consultation responses. The consultation included a question on whether five-yearly reviews should be undertaken on the strategy.

A23. This AMS has been informed by the Government's Net Zero strategy published in October 2021, setting out its plan to tackle climate change across all sectors of the economy.[64] In terms of aviation, the Government reinforces its support for the development of new and zero-carbon aircraft technology, as well as accelerating the commercialisation of UK sustainable aviation fuel.

Airport capacity

A24. A key part of the 2018 AMS was the need to enable sustainable growth in capacity in the system, as discussed in Chapter 2. In December 2018, the Government published a Green Paper consulting on how it saw sustainable growth being delivered.[65] In light of the unprecedented impacts that the Covid-19 pandemic has had on the sector, the Government is, at the time of writing, developing a medium-term strategic framework for the sector considering key future issues including decarbonisation, international and domestic connectivity, airspace modernisation, skills and innovation. This strategy is expected to be published in 2022.

A25. Following the designation of the Airports National Policy Statement (ANPS)[66] in June 2018, it has been subject to legal challenge, which was ultimately unsuccessful before the Supreme Court in December 2020. The ANPS sets out that there is a need to increase airport capacity in the South East of England by 2030 and that the Government's preferred scheme is a new northwest runway at Heathrow. Following a number of requests to review the ANPS, the Secretary of State confirmed his decision in his open letter of 6 September 2021 stating that it was not appropriate to review the ANPS at that time, and that the question of

64 *Net Zero Strategy: Build Back Greener*, HMG, October 2021. https://www.gov.uk/government/publications/net-zero-strategy

65 *Aviation 2050: The future of UK Aviation: a consultation*, HMG, December 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769695/aviation-2050-web.pdf

66 *Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England*, Department for Transport June 2018. https://www.gov.uk/government/publications/airports-national-policy-statement

whether or not to review the ANPS should be considered again after the Government's Jet Zero Strategy has been finalised.[67]

A26. In June 2018 the Government also set out its approach to capacity at other airports in its 'Making best use of existing runways' policy, where it confirmed that it is supportive of airports beyond Heathrow making best use of their existing runways as long as they address the economic and environmental impacts and proposed mitigations.[68]

A27. In October 2021, alongside its Net Zero Strategy, the Government published its response to the report by the Climate Change Committee *Progress in Reducing Emissions*.[69] The Committee had recommended that the Government assess its airport capacity strategy in the context of Net Zero and any lasting impacts on demand from Covid-19, as part of the aviation strategy. The Committee had also recommended that there should be no net expansion of UK airport capacity unless the sector was on track to sufficiently outperform its net emissions trajectory and could accommodate the additional demand.

A28. The Government's response stated that flying is a social and economic good, and one that it wholeheartedly supported as a key part of building a global Britain. The Government went on to say that it currently believed that the aviation sector, even if returning to a pre-Covid-19 demand trajectory, could achieve Jet Zero without the Government needing to intervene directly to limit aviation growth. Department for Transport analysis showed that there are scenarios where net zero targets can be achieved by focusing on new fuels and technology, rather than capping demand, with knock-on economic and social benefits. The Government also reaffirmed its commitments to increase system efficiencies including the airspace modernisation programme. As noted above the Government is expected to publish a Jet Zero Strategy in 2022.

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67 *Decision on requests to review the Airports National Policy Statement under the Planning Act 2008*, Department for Transport, September 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015207/decision-on-requests-to-review-the-anps.pdf

68 *Beyond the horizon: the future of UK aviation, making best use of existing runways*, Department for Transport June 2018. https://www.gov.uk/government/publications/aviation-strategy-making-best-use-of-existing-runways

69 Climate Change Committee's 2021 progress report: Government response, HMG, October 2021 https://www.gov.uk/government/publications/committee-on-climate-changes-2021-progress-report-government-response

ICAO and Europe

International Civil Aviation Organization (ICAO)

A29. ICAO is a specialist agency of the United Nations which acts as a global forum of States for international civil aviation. As a contracting state, the UK has airspace modernisation obligations under the ICAO Global Air Navigation Plan (GANP).

A30. Before the UK left the EU, the UK's obligations under the GANP were delivered through the Single European Sky (SES), and associated European ATM (air traffic management) Masterplan, which was used to produce the necessary regulations regarding airspace modernisation that had direct legal effect in the UK.

A31. While some of this legislation has been retained as domestic law and continues to apply in the UK through the European Union (Withdrawal) Act 2018, the UK's modernisation programme and the legislation underpinning it will need to be updated as developments occur to ensure its obligations under the GANP are met, while at the same time adopting a national approach, making best use of global learning and delivering globally interoperable capabilities.

Single European Sky

A32. The Single European Sky programme sets out a range of airspace modernisation requirements in EU law, mainly focusing on commercial air transport operations and larger airports with a significant impact on the core European airspace network. The legislation also requires en route air navigation service providers to meet a set of performance targets for safety, cost efficiency, environmental performance and delays, which are set at the national and EU level.

A33. Other implementing regulations developed by EASA that cover navigation, surveillance and air traffic management are much broader in scope and set requirements for the way certain aerodromes and aircraft operations, inside and outside controlled airspace, are to be modernised.

A34. As stated above, EU Regulations enabling the European ATM Master Plan are agreed and adopted by the European Commission and EU member states. Some of this legislation has been retained as domestic law and continues to apply in the UK – in an amended form such that it still applies and operates properly in UK law – through the European Union (Withdrawal) Act 2018. For example, the SESAR Pilot Common Project (PCP), with the first set of air traffic management functionalities or solutions, had direct legal effect in the UK and is now retained EU law.

A35. The UK's roadmap to meet its ICAO obligations in relation to the GANP is this AMS which will drive the UK's rulemaking process for airspace modernisation.[70] The delivery elements in AMS Part 2 will therefore be used to assist in the prioritisation of UK airspace rulemaking activity to help ensure their timely and coordinated implementation.

Relations with Europe

A36. Around 25 percent of traffic passing through EU airspace also passes through UK airspace, including around 80 percent of transatlantic traffic. Consequently there is a continuing need for greater interoperability in airspace management arrangements between the UK and the rest of Europe. The UK remains part of the pan-European air traffic management system and has co-operative arrangements with other European states, principally through its membership of the EUROCONTROL intergovernmental organisation and industrial partnerships such as Borealis.[71]

Accepting the airspace change masterplan into the AMS

A37. The airspace change masterplan is a single coordinated implementation plan for airspace changes in the UK to cover the period to 2040 – those airspace change proposals identified as strategically important to the modernisation of the UK's airspace. It is encompassed by Delivery Element UK-ABN/2 (see Chapter 4 and AMS Parts 2 and 3).[72]

A38. The CAA and Department for Transport, as co-sponsors of airspace modernisation in the UK, commissioned NATS (En Route) plc (NERL) to create the masterplan.[73] The co-sponsors required NERL to set up a separate and impartial body to coordinate the airspace changes necessary to deliver airspace modernisation. This body is known as the Airspace Change Organising Group (ACOG).[74]

A39. Part of the regulatory framework involves the co-sponsors assessing ACOG's progress to confirm that the masterplan is consistent with the masterplan commission, government policy and the CAA's own statutory airspace functions.

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70 https://info.caa.co.uk/uk-regulations/

71 https://www.sesardeploymentmanager.eu/partners/borealis-alliance

72 Formerly Initiatives 4 and 5 of the 2018 AMS: FASI-S, terminal airspace redesign in Southern England; and FASI-N, terminal airspace redesign in Northern England and Scotland. FASI-S and FASI-N mean Future Airspace Strategy Implementation–South and –North respectively, see https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Airspace-Modernisation-Strategy---Future-Airspace-Implementation-programmes/

73 The commissions are published as Appendix A to CAP 2156a *Airspace change masterplan – CAA acceptance criteria* www.caa.co.uk/cap2156a.

74 www.acog.aero

Based on that assessment, and before the masterplan can be implemented, the CAA must decide to formally 'accept' the masterplan into the AMS, having consulted the Secretary of State. Each iteration must be accepted separately, except Iteration 1, which has already been assessed and published. ACOG envisages a minimum of four iterations of the masterplan.

A40. The CAA has published the criteria for accepting the masterplan into the AMS and the related assessment framework.[75] The CAA's acceptance of the masterplan into the AMS makes the masterplan, together with CAP 1616, the legal basis against which individual airspace change decisions are made by the CAA.

A41. Acceptance of the masterplan forms part of the delivery plan in Part 3 of this strategy. Progress with assessing individual iterations of the masterplan can be tracked on the CAA's airspace change masterplan webpages[76], or through the CAA's annual progress reports to the Secretary of State.[77]

Procedure for the CAA to review the classification of airspace

A42. Initiative 10 of the 2018 AMS was an airspace classification review to optimise the integration of all classes of aircraft. This is consistent with the CAA's airspace classification functions under the Air Navigation Directions, including the function of regularly considering whether airspace classifications should be reviewed, carrying out such reviews and considering and making changes to airspace classification as the CAA considers appropriate.

A43. The procedure to review the classification of airspace, CAP 1991[78], is functionally separate from the CAP 1616 airspace change process, but plans for change under CAP 1991 will be shared with those processing plans for change under CAP 1616 to ensure coherence with the broader programme to modernise UK airspace. Part of the regulatory framework involves a three-stage procedure where we draw up a plan that lists airspace volumes where a case could be made for a proposed amendment to the classification, and a proposed schedule

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75 CAP 2156a *Airspace change masterplan – CAA acceptance criteria* www.caa.co.uk/cap2156a, CAP 2156b *Airspace change masterplan – assessment framework* www.caa.co.uk/cap2156b, CAP 2156c *Airspace change masterplan - future opportunities to express views* www.caa.co.uk/cap2156c.

76 https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/Airspace-Modernisation-Update/. New CAA webpages for the AMS and masterplan are being created.

77 See progress reports for 2019, 2020 and 2021 www.caa.co.uk/cap1862, www.caa.co.uk/cap2016, www.caa.co.uk/cap2281. The co-sponsors' assessment of Iteration 1 of the masterplan is at www.caa.co.uk/cap1884.

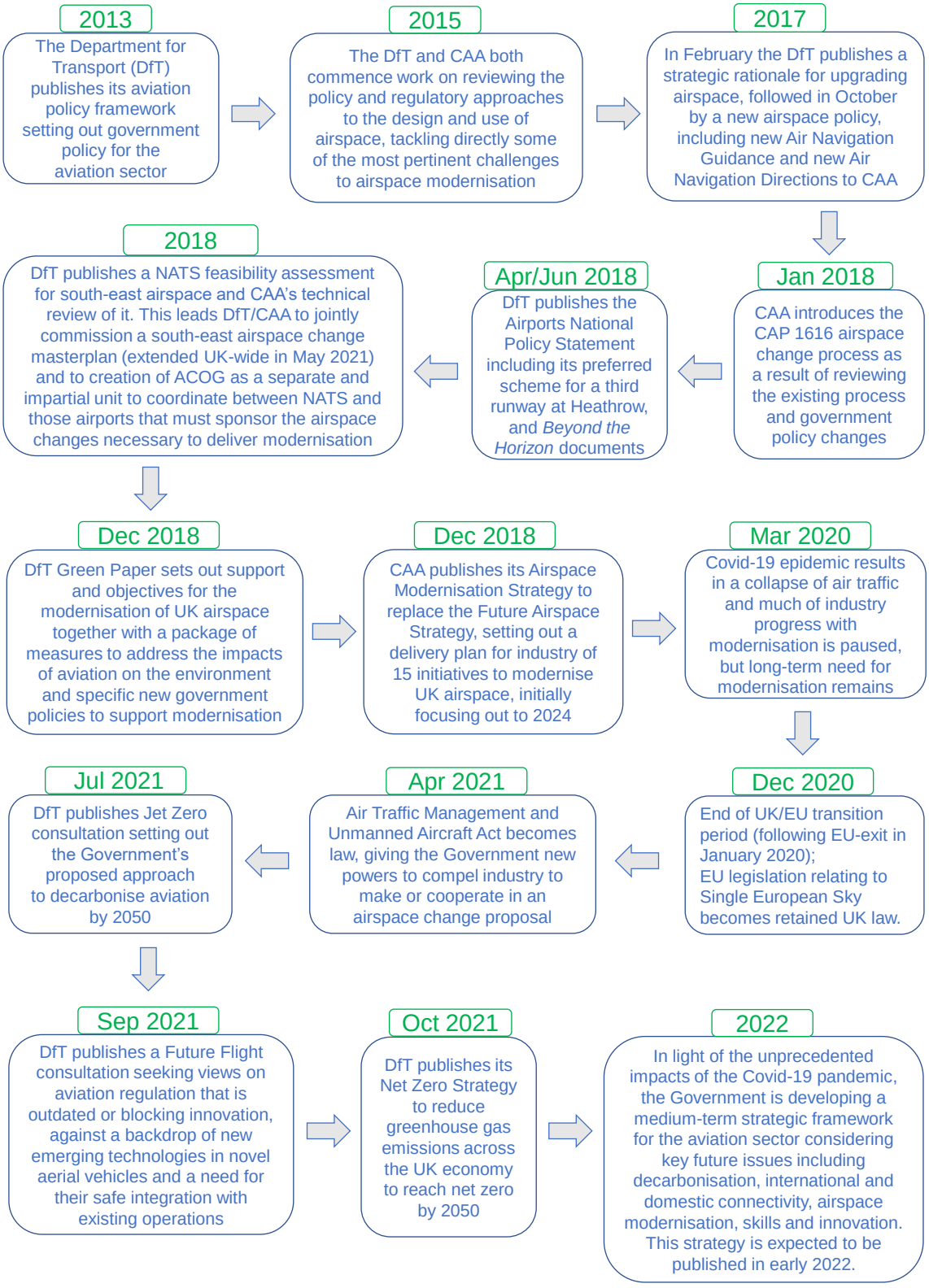
78 CAP 1991 *Procedure for the CAA to review the classification of airspace*. www.caa.co.uk/cap1991 and CAP 1991a *Summary of the procedure for the CAA to review the classification of airspace*. www.caa.co.uk/cap1991a

for when we will address them. After stakeholder consultation and engagement, we adopt the final plan as part of the AMS deployment plan in Part 3. Formal proposals based on that final plan are then worked up and actioned. Progress can also be tracked on the CAA's airspace classification webpages[79] or through the CAA's annual progress reports to the Secretary of State (referenced above).

Summary of developments

A44. Key developments in the airspace legal and policy context are summarised in Figure A1 below. The developments presented in this figure are non-exhaustive and intended only to provide a general overview.

[79] https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Airspace-classification/



Notes:

The developments presented in this figure are non-exhaustive and intended only as a general overview. Links to the source documents are overleaf.

Figure A1: Key developments in the airspace legal and policy context

Source documents for Figure A1:

2013	*Aviation Policy Framework* Department for Transport	https://www.gov.uk/government/publications/aviation-policy-framework
2017	*Upgrading UK Airspace – Strategic Rationale,* Department for Transport	https://www.gov.uk/government/publications/upgrading-uk-airspace-strategic-rationale https://www.gov.uk/government/publications/uk-airspace-policy-a-framework-for-the-design-and-use-of-airspace
2017	Air Navigation Directions (CAA consolidated version)	https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Legislative-framework-to-airspace-change/
2017	*Air Navigation Guidance*, Department for Transport	www.gov.uk/government/publications/uk-air-navigation-guidance-2017
2018	CAP1616: *Airspace change: Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information*	www.caa.co.uk/cap1616
2018	*Beyond the horizon, the future of UK aviation, next steps towards an Aviation Strategy*, HMG	https://www.gov.uk/government/consultations/a-new-aviation-strategy-for-the-uk-call-for-evidence
2018	*Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England*, Department for Transport	https://www.gov.uk/government/publications/airports-national-policy-statement
2018	*Beyond the horizon: the future of UK aviation, making best use of existing runways*, Department for Transport	https://www.gov.uk/government/publications/aviation-strategy-making-best-use-of-existing-runways
2018	*NATS Feasibility Report into Airspace Modernisation in the South of the UK and the CAA Assurance into the NATS Feasibility Report*, Department for Transport	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/763085/nats-caa-feasibility-airspace-modernisation.pdf
2018	Commission of masterplan see Appendix A to CAP 2156a *Airspace change masterplan – CAA acceptance criteria*	www.caa.co.uk/cap2156a
	NERL economic licence condition 10a	www.caa.co.uk/cap2111
2018	*Aviation 2050: The future of UK Aviation: a consultation*, HMG	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769695/aviation-2050-web.pdf
2018	CAP 1711 *Airspace Modernisation Strategy*	www.caa.co.uk/cap1711 www.caa.co.uk/cap1711b
2020	Retained UK law	https://info.caa.co.uk/uk-regulations/
2021	Funding support package	https://www.gov.uk/government/publications/update-on-airspace-modernisation/dft-and-caa-update-on-airspace-modernisation-march-2021 https://www.gov.uk/government/news/55-million-to-drive-improvements-to-uks-motorways-in-the-sky
2021	Air Traffic Management and Unmanned Aircraft Act 2021	https://www.legislation.gov.uk/ukpga/2021/12/contents/enacted
2021	Jet Zero consultation	https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050
2021	Future of transport regulatory review consultation: Future of flight	https://www.gov.uk/government/consultations/future-of-transport-regulatory-review-future-of-flight
2021	Net Zero Strategy	https://www.gov.uk/government/publications/net-zero-strategy

APPENDIX B

Glossary

Although we have only used abbreviations in this document where unavoidable, in the interests of completeness we have included below some common abbreviations – as well as other terms – that relate to airspace modernisation. See also CAP 1430 *UK Air Traffic Management Vocabulary* www.caa.co.uk/cap1430.

Term	Abbreviation	Description
Advanced air mobility	AAM	An aerial solution to alleviate transport congestion including air taxis and autonomous flying vehicles (also known as urban air mobility where intended for use in built-up areas).
Advanced flexible use of airspace	AFUA	See flexible use of airspace.
Aerodrome Flight Information Service Officer	AFISO	A Flight Information Service Officer at an aerodrome (see Flight Information Service).
Aerodrome traffic zone	ATZ	Aerodrome traffic zone – normally, circular zones around an aerodrome where pilots and air traffic services providers must follow specific requirements.
Aeronautical Information Management	AIM	The dynamic, integrated management of aeronautical information services through the provision and exchange of quality-assured digital aeronautical data, in collaboration with all parties.
Aeronautical Information Publication	AIP	Long-term information essential to air navigation, including the detailed structure of UK airspace and flight procedures, which forms part of the UK Integrated Aeronautical Information Package. Sometimes informally known as the Air Pilot. Publication is the responsibility of the CAA, but is carried out under licence by NATS. www.ais.org.uk
Air Ground Communications Service	AGCS	A service provided to pilots at specific UK aerodromes that is not viewed by the UK as an air traffic service, because it does not include an alerting service as part of its content. AGCS radio station operators provide traffic and weather information to pilots operating on and in the vicinity of the aerodrome. Such traffic information is based primarily on reports made by other pilots. Information provided by an AGCS radio station operator may be used to assist a pilot in making a decision; however, the safe conduct of the flight remains the pilot's responsibility.

Term	Abbreviation	Description
Air Navigation Directions		The Civil Aviation Authority (Air Navigation) Directions 2017, as amended in 2018 and 2019. These Directions give the CAA its functions in relation to air navigation, including to prepare and maintain the AMS. They are jointly issued by the Secretary of State for Transport and the Secretary of State for Defence. A consolidated version is on the CAA's website. https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Legislative-framework-to-airspace-change/
Air Navigation Guidance	ANG	Guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management, October 2017, Department for Transport. www.gov.uk/government/publications/uk-air-navigation-guidance-2017
Air navigation service provider	ANSP	An organisation which operates the technical system, infrastructure, procedures and rules of an air navigation service system, which may include air traffic control.
Air traffic control	ATC	Service from an air navigation service provider providing guidance to aircraft through controlled airspace.
Air traffic management	ATM	The combined processes of air traffic control, air traffic flow management, and aeronautical information services. ATM can also mean air transport movement.
Air traffic service	ATS	Generic term that covers flight information services, alerting services, air traffic advisory services, air traffic control services (area control service, approach control service or aerodrome control service) and aerodrome flight information services.
Air traffic services airspace	ATS Airspace	Airspace in which control by air traffic services and specific rules of operations are required.
Airport Collaborative Decision Making	A-CDM	Systems and processes to enable the creation, refinement and exchange of up-to-date runway and airspace data between the airport, air traffic control, airlines and ground handlers about the status of inbound and outbound flights, enabling better-informed, more consistent decision making.
Airspace Change Organising Group	ACOG	The CAA and Department for Transport, as co-sponsors of airspace modernisation in the UK required NERL to set up ACOG as a separate and impartial body to coordinate the airspace changes necessary to deliver airspace modernisation in the form of a masterplan. www.acog.aero

Term	Abbreviation	Description
Airspace change process	CAP 1616 process	The staged process an airspace change sponsor follows to submit an airspace change to the CAA for a decision. CAP1616: *Airspace change: Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information.* www.caa.co.uk/cap1616 with supporting documents CAP 1616a, CAP 1617, CAP 1618 and CAP 1619 www.caa.co.uk/cap1616a etc
Airspace change proposal	ACP	A proposal (usually from an airport or air navigation service provider) to change the design of UK airspace.
Airspace design		Together, the airspace structure and flight procedures.
Airspace management cell	AMC	A joint civil/military cell responsible for the day-to-day management and temporary allocation of national or sub-regional airspace under the jurisdiction of one or more European Civil Aviation Conference states.
Airspace Modernisation Strategy	AMS	A co-ordinated strategy and plan for the use of all UK airspace for air navigation up to 2040, including for the modernisation of the use of such airspace. Originally published in December 2018 as CAP 1711 www.caa.co.uk/cap1711 and CAP 1711b www.caa.co.uk/cap1711b to replace the previous Future Airspace Strategy, it is now being refreshed in three parts plus an annex and currently subject to consultation. The CAA must report to the Secretary of State annually on the delivery of the strategy. https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/About-the-strategy/
Airspace Modernisation Strategy Support Fund	AMSSF	A fund to aid projects in support of the delivery of airspace modernisation where delivery benefits multiple stakeholders and or research will enable wider industry deployment. https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/Airspace-Modernisation-Strategy-Support-Fund/
Aviation System Block Upgrade	ASBU	The building blocks of the ICAO Global Air Navigation Plan with workstreams organised into ‘threads’ and ‘elements’, ASBUs provide a global planning framework to ICAO and its member states, associated air navigation service providers and other stakeholders with the goal of implementing regional performance improvements.

Term	Abbreviation	Description
Airspace4All Trust	A4A	A charity representing the interests of UK recreational aviation, air sports, private pilots and flight training, primarily in relation to the AMS and individual airspace change proposals. https://a4atrust.org/
Airspace structure		Designated volumes of airspace within identified characteristics, including the equipment aircraft wanting to enter that airspace must carry and actions pilots must carry out before entering that airspace. The volumes of airspace are designed to ensure the safe and optimal operation of aircraft. Airspace structures consist of: ▪ controlled airspace, namely control zones, control areas, terminal control areas and airways ▪ airspace restrictions, namely danger, restricted and prohibited areas ▪ radio mandatory zones, transponder mandatory zones ▪ other airspaces specified by the CAA when defining the airspace change process, such as, for example, flight information zones, aerodrome traffic zones, temporary segregated areas, temporary reserved areas or free-route airspace.
Airway		A corridor of controlled airspace of defined width with a defined lower base, extending to Flight Level 245 (a nominal altitude of 24,500 feet) unless otherwise denoted.
Area navigation	RNAV	A method of navigation which permits aircraft operation on any desired flightpath within the coverage of ground- or space-based navigation aids or within the capability of self-contained aids, or a combination of these. (ICAO Doc 9613) www.icao.int
Area navigation routes		An air traffic services route created for aircraft capable of employing performance-based navigation technology.
Association of Remotely Piloted Air Systems UK	ARPAS-UK	The professional body and trade association for the RPAS industry/
Automatic dependent surveillance – broadcast	ADS-B	A surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked

Term	Abbreviation	Description
Beyond visual line of sight	BVLOS	Where a remote pilot is unable to maintain direct unaided visual contact with an uncrewed aircraft while it is airborne, requiring an alternative method of collision avoidance to maintain safety.
Carbon dioxide	CO_2	Naturally occurring atmospheric gas, which causes greenhouse effects leading to global warming, and ocean acidification in increased concentrations.
Classes of airspace		Airspace is broken down into different classes, defined by ICAO. In the UK, Classes A, C, D and E are controlled airspace and Class G is uncontrolled airspace (Classes B and F are currently unused in the UK).
(Integrated) communications, navigation and surveillance and spectrum	CNS&S ICNSS	Technological infrastructure supporting air traffic services provision. Integrated CNS is the next generation of CNS technologies supporting the modernisation and interoperability of the global air traffic management system envisaged by GANP.
Continuous climb (or descent) operations	CCO or CDO	Allow arriving or departing aircraft to descend or climb continuously, to the greatest extent possible.
Control area	CTA	Area of controlled airspace, usually surrounding an aerodrome, extending from ground level to a specified altitude.
Control zone	CTR	Area of controlled airspace, usually surrounding an aerodrome, extending between two specified altitudes.
Controlled airspace	CAS	Airspace in which air traffic control must have control over aircraft to maintain safe separation between them.
Danger area		Airspace within which activities dangerous to the flight of aircraft may exist at notified times.
Data link automatic terminal information service	DATIS	ATIS broadcasts contain essential information, such as current weather information, active runways, available approaches, and any other information required by the pilots, such as important NOTAMs. DATIS is the automatic provision of this information to arriving and departing aircraft via datalink.
Drone		Commonly used term for an unmanned aerial system or vehicle (UAS or UAV), a powered aircraft without a human pilot on board. Drones may be remotely piloted (also known as a remotely piloted air system or RPAS) or autonomous. Drones range from relatively large aircraft similar in size and complexity to an aircraft with a pilot on board, to much smaller hand-held types with minimal payload, such as those for recreational use. https://www.caa.co.uk/Consumers/Unmanned-aircraft/Our-role/An-introduction-to-unmanned-aircraft-systems/

Term	Abbreviation	Description
Electronic conspicuity	EC	An umbrella term for the technology that allows airspace users to detect all others and be detected by all others. Electronic conspicuity can help pilots, remotely piloted aircraft systems and air traffic service providers be more aware of what is operating in surrounding airspace. It includes the devices fitted to aircraft that send out the information and the supporting infrastructure to help them work together; examples are airborne transponders, air traffic data displays, ground-based antennas and satellite surveillance services.
Element		In the AMS, nine delivery elements provide the essential detail of the development activities making up the strategy. These are derived from the ICAO GANP ASBU framework, tailored to the needs of UK airspace. Initiatives from the 2018 AMS, delivery of which will continue, are subsumed into the refreshed AMS.
En route holding		Pattern adopted by aircraft on the instruction of air traffic services to manage delay and sequencing, and hold them in the air until onward clearance (usually to land) is provided.
En route phase		That part of the flight from the end of the take-off and initial climb phase to the commencement of the approach and landing phase.
EUROCONTROL		An intergovernmental organisation with 41 European member states, plus Israel and Morocco acting as the central organisation for coordination and planning of air traffic control for all of Europe.
European Aviation Safety Agency	EASA	The European Union authority for aviation safety.
Flexible use of airspace	FUA	Concept promoted by EUROCONTROL wherein airspace is no longer designated as purely ‘civil’ or ‘military’ airspace, but considered as one continuum and allocated according to user requirements. FUA is being replaced by advanced flexible use of airspace (AFUA).
Flight and flow information	FF-ICE	Flight and flow information for a collaborative environment: information necessary for notification, management and coordination of flights between members of the ATM community within the collaborative environment envisioned in the ICAO Global ATM Operational Concept.
Flight information region	FIR	Specified region of airspace, co-ordinated through the International Civil Aviation Organization.
Flight Information Service	FIS	A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Term	Abbreviation	Description
Flight Information Service–Broadcast	FIS-B	A data broadcasting service that works along with electronic conspicuity to allow aircraft operators to receive aeronautical information such as weather and airspace restrictions through a datalink to the cockpit.
Flight level	FL	Altitude above sea-level in 100 feet units measured according to a standard atmosphere.
Flight procedures		Part of the airspace design. A set of predetermined segments intended to be followed by a pilot when arriving to or departing from an aerodrome.
Flight restriction zone	FRZ	Zones created around aerodromes that are designated as 'protected aerodromes'. Unmanned aircraft of any size must not be flown within the FRZ of a protected aerodrome without appropriate permission.
Flight rules		Aircraft can operate under Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). There is also an intermediate form, Special Visual Flight Rules (SVFR).
Free-route airspace	FRA	Specified airspace within which users may freely plan a route between defined entry and exit points either direct or via intermediate waypoints without reference to the ATS route network, subject to airspace availability.
Future Airspace Strategy	FAS	Replaced by the Airspace Modernisation Strategy, FAS was a collaborative initiative between a range of stakeholders for modernising the UK's airspace. www.caa.co.uk/fas https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-Modernisation-Strategy/About-the-strategy/
Future Communications Infrastructure	FCI	An internet protocol suite system providing the digital and secure communication capabilities able to support integrated Communication, Navigation and Surveillance (ICNS) by providing the network functionality to interconnect air and ground end-systems networks.
General Aviation	GA	Essentially all civil flying other than commercial airline operations, which therefore encompasses a wide range of aviation activity from paragliders, microlights, gliders and balloons to corporate business jets and aerial survey aircraft, and includes all sport and leisure flying. https://www4.icao.int/ganpportal/document/inputGA
Global Navigation Satellite System	GNSS	A worldwide position, velocity, and time determination system that includes one or more satellite constellations, receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation – for example, GPS (Global Positioning System) is an implementation of GNSS.

Term	Abbreviation	Description
High-altitude platform system	HAPS	Typically a remotely piloted fixed-wing aircraft or airship/balloon operating for an extended period at high altitude (probably above 60,000ft) providing services such as broadband connectivity or remote sensing.
Holding pattern		Flight pattern adopted by aircraft to hold until cleared to land by air traffic control.
Holding stack		Airspace used to 'hold' aircraft until they are able to land at an airport. Heathrow airport has four stacks set by government.
Independent Commission on Civil Aviation Noise	ICCAN	An independent UK body responsible for creating, compiling and disseminating best practice to the aviation industry on the management of civil aviation noise and advising government in this area. The Government decided to wind down ICCAN at the end of September 2021 and some of its responsibilities were transferred to the CAA. https://www.gov.uk/government/speeches/independent-advice-to-government-on-civil-aviation-noise
Instrument approach procedure	IAP	A set series of aircraft manoeuvres from the initial approach to landing.
Industry Communications for the Airspace Modernisation Strategy	ICAMS	Implementation group representing largely commercial aviation industry interests in FAS. Formerly known as the Future Airspace Strategy Industry Implementation Group (FASIIG).
Instrument flight procedures	IFP	Procedures designed to international/ national criteria, published in the UK AIP, flown by aircraft with reference to ground-based or satellite-based navigation aids and most usually associated with arrival at or departure from an airport.
Instrument flight rules	IFR	The rules under which a pilot can fly and navigate an aircraft, in certain weather conditions, primarily through use of on-board instruments.
Instrument meteorological conditions	IMC	Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.
International Civil Aviation Organization	ICAO	The agency of the United Nations responsible for international standards for civil aviation which the UK is bound by international treaty to implement.
Jet Zero		The Government's vision for the aviation sector to reach net zero aviation emissions, or jet zero, by 2050, with the ambition to decarbonise aviation in a way that preserves the benefits of air travel and maximise the opportunities that decarbonisation can bring. https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050

Term	Abbreviation	Description
Local Single Sky implementation monitoring	LSSIP	LSSIP documents provide an annual view of how 41 member states of EUROCONTROL (plus Israel and Morocco) and relevant stakeholders are progressing in planning and deploying the mature elements of the European ATM Master Plan. https://www.eurocontrol.int/service/local-single-sky-implementation-monitoring
London Approach		(See also terminal air navigation services.) The approach service for a number of airports can be combined and, in the case of the airports within the London terminal manoeuvring area, these have been centralised for safety and efficiency reasons. The unified approach service, the so-called 'London Approach' service, is provided by NERL.
Lower air traffic services route	Lower ATS Route	An air traffic route notified in the UK aeronautical information publication in lower airspace.
Lower airspace		Controlled airspace below Flight Level 245 (a nominal altitude of 24,500 feet).
Lower airspace radar service	LARS	A service available to all aircraft for the provision of the radar element of UK Flight Information Services, usually available within approximately 30 nm of each participating Air Traffic Service Unit to all aircraft flying outside controlled airspace up to Flight Level 100, within the limits of radar/radio cover and set times.
Lower airspace service	LAS	A replacement for LARS. This is the future lower airspace service which will provide a FIS where and when required to better support both self-management of piloted VFR (Visual Flight Rules) aircraft and drone operators in class G airspace.
Masterplan		A single coordinated implementation plan for airspace changes in the UK to cover the period to 2040, commissioned from the Airspace Change Organising Group by the Department for Transport and CAA, co-sponsors of airspace modernisation. www.acog.aero There is also a European ATM Master Plan. https://www.sesarju.eu/masterplan
Meteorological Terminal Air Report	METAR	A format for reporting weather information, typically containing temperature, dew point, wind, precipitation, cloud cover and heights, visibility and barometric pressure.
National Air Traffic Management Advisory Committee	NATMAC	National Air Traffic Management Advisory Committee. An advisory body chaired by the CAA with representation across the UK aviation community, consulted for advice and views on airspace management and strategy matters.

Term	Abbreviation	Description
NATS		The biggest air navigation service provider in the UK, formerly National Air Traffic Services. Parent company of NERL (NATS (En Route) plc) and NSL (NATS Services Limited). www.nats.co.uk
NATS (En Route) plc	NERL	Subsidiary of NATS Holdings Ltd and the sole provider of air traffic control services for aircraft flying en route in UK airspace. NERL also provides some air traffic control services in the eastern part of the North Atlantic, as well as providing a combined approach function (London Approach) for five London airports.
Net Zero		The Government's strategy setting out policies and proposals for decarbonising all sectors of the UK economy to meet our net zero target by 2050. https://www.gov.uk/government/publications/net-zero-strategy
Noise preferential route	NPR	Aircraft departing from certain airports follow set departure routes agreed by Government or the Local Authority, with the aim of providing certainty in respect of, and, where possible, minimising noise impacts on the ground. Noise preferential routes are not decided by the CAA.
Non-cooperative radar		Radar which can detect aircraft regardless of their equipment.
Non-directional beacon	NDB	Radio transmitter at a specified location used by aircraft as a navigational aid.
Notice to Air Missions	NOTAM	A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
Notified airspace design		Details of airspace structure and procedures published in the UK aeronautical information publication.
Performance-based navigation	PBN	A concept developed by ICAO that moves aviation away from the traditional use of aircraft navigating by ground-based beacons to a system more reliant on airborne technologies, utilising area navigation and global navigation satellite systems. (Air Navigation Guidance 2017). More specifically, area navigation based on performance requirements for aircraft operating along an ATS route, or an instrument approach procedure or in a designated airspace. (ICAO Doc 9613) https://www.icao.int
Performance-based surveillance	PBS	Surveillance based on performance specifications applied to the provision of air traffic services.

Term	Abbreviation	Description
Pilot common project	PCP	The first set of air traffic management functionalities identified for wide scale coordinated deployment under SESAR.
(Alternative) position navigation and timing	PNT A-PNT	PNT services are provided by the Global Navigation Satellite System (GNSS) and have three elements: • Positioning, the ability to accurately and precisely determine one's location and orientation two-dimensionally (or three-dimensionally when required) referenced to a standard geodetic system (such as World Geodetic System 1984, or WGS84) • Navigation, the ability to determine the current and desired position (relative or absolute) and apply corrections to course, orientation and speed to attain the desired position anywhere around the world, from sub-surface to surface and from surface to space, and • Timing, the ability to acquire and maintain accurate and precise time from a standard (Coordinated Universal Time, or UTC), anywhere in the world and within user-defined timeliness parameters. Timing also includes time transfer. Alternative PNT is the use of high precision back-ups to GNSS.
Procedures for Air Navigation – Operations	PANS-OPS	Rules for designing instrument approach and departure procedures.
Prohibited area		An area of airspace of defined dimensions within which the flight of aircraft is prohibited.
Radio mandatory zone	RMZ	Defined airspace structure in which the carriage and operation of radio equipment is mandatory unless previously agreed.
Remotely piloted air system	RPAS	A powered aircraft without a human pilot on board which is piloted remotely, also known as an unmanned aerial system or vehicle (UAS or UAV). See also 'drone'. https://www.caa.co.uk/Consumers/Unmanned-aircraft/Our-role/An-introduction-to-unmanned-aircraft-systems/
Required navigation performance	RNP	Type of performance-based navigation. See Performance Based Navigation.
Respite		Planned and notified periods where overflight or noise impact are reduced or halted to allow communities undisturbed time.
Restricted area Restricted area (temporary)	RA RA(T)	An area of airspace of defined dimensions within which the flight of aircraft is restricted in accordance with certain conditions.

Term	Abbreviation	Description
Secondary surveillance radar	SSR	Type of radar which both detects and sets position of aircraft in the air, and also receives information from the aircraft.
Significant meteorological information	SIGMET	Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations.
Single European sky	SES	European legislation that supports a programme of modernisation and harmonisation of airspace structures and air traffic control methods for a more systemised and efficient European air traffic management system.
Single European sky air traffic management research	SESAR	European project which concerns the roll-out of new technology across the European Union.
Special visual flight rules	SVFR	A special case of operating under visual flight rules.
Sponsor (or change sponsor)		An organisation that proposes, or sponsors, a change to the airspace design in accordance with the CAA's airspace change process.
Standard arrival route	STAR	Published flight procedures followed by aircraft on an Instrument Flight Rules (IFR) flightplan just before reaching a destination airport. More specifically, a STAR is a designated IFR arrival route linking a significant point, normally on an ATS route, with a point from which a published Instrument Approach Procedure (IAP) can be commenced.
Standard instrument departure	SID	Published flight procedures followed by aircraft on an Instrument Flight Rules (IFR) flightplan immediately after take-off. More specifically, a SID is a designated IFR departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en route phase of a flight commences.
Standards and recommended practices	SARPs	Technical specifications set by the International Civil Aviation Organization for aviation, implemented and regulated national by states globally to manage safety risks.
State Safety Programme	SSP	The basis for managing aviation safety in the UK. https://www.caa.co.uk/safety-initiatives-and-resources/how-we-regulate/state-safety-programme/

Term	Abbreviation	Description
System-wide Information Management	SWIM	A set of internet-based information sharing standards and protocols that support aeronautical data. Supports exchanges between European civil and military air navigation service providers, airspace users, airport operators, meteorological service providers and the European network manager.
Terminal air navigation services	TANS	Terminal air navigation services comprise two elements: the 'radar approach and departure' (approach control) service, and the aerodrome control service. The approach service typically takes control of the aircraft from the en route service within 40–50 nautical miles of the airport, and sequences aircraft for landing before handing over to aerodrome control. It also takes control of aircraft on departure from aerodrome control. Aerodrome control manages (visually from the airport's control tower) aircraft taking off and landing, and ground movement control of aircraft taxiing between the runway and the stands These two elements of terminal air navigation services are provided by the airport (acting as an air navigation service provider) itself, or by a third-party air navigation services provider.
Terminal control area		Area of controlled airspace surrounding an airport.
Terminal manoeuvring area	TMA	A designated area of controlled airspace surrounding a major airport where there is a high volume of traffic.
Time-based operations	TBO	Helping to manage traffic flows and trajectories by scheduling and metering aircraft through congested airspace resources or constraint points. Metering means time-regulating arrival traffic flow into a terminal area so as not to exceed a predetermined acceptance rate.
Traffic Information Service–Broadcast	TIS-B	TIS-B is a surveillance service aimed to improve pilots' in-flight awareness of the nearby traffic. It provides for display of both broadcasted by appropriately equipped aircraft identity, position, altitude, speed (and other parameters) and surveillance tracks processed by regional control facilities and transmitted by ground broadcast stations.
Trajectory-based operations	TBO	Defined in four dimensions (4D) – latitude, longitude, altitude and time – the trajectory represents a common reference for where an aircraft is expected to be – and when – at key points along its route. The trajectory is defined prior to departure, updated in response to emerging conditions and operator inputs, and shared between stakeholders and systems. The aggregate set of aircraft trajectories on the day of operation defines demand, and informs traffic management actions.

Term	Abbreviation	Description
Transition altitude	TA	The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes based on local rather than standard pressure.
Transponder		An electronic device that produces a response when it receives a radio-frequency interrogation. Aircraft have transponders to assist in identifying them on air traffic control radar.
Transponder mandatory zone	TMZ	Defined airspace structure in which the carriage and operation of transponder equipment is mandatory unless previously agreed.
Uncontrolled airspace		Airspace in which aircraft are able to fly freely through the airspace without being constrained by instructions in routeing or by air traffic control, unless they require an air traffic control service.
Unmanned aircraft system Unmanned aerial vehicle	UAS UAV	A powered aircraft without a human pilot on board, which may be remotely piloted (also known as a remotely piloted air system or RPAS) or autonomous. See also 'drone'. https://www.caa.co.uk/Consumers/Unmanned-aircraft/Our-role/An-introduction-to-unmanned-aircraft-systems/
UAS traffic management	UTM	The interaction between traditional air traffic management systems and the evolving counterpart systems being developed for drones.
Upper air traffic services route	Upper ATS route	An air traffic route notified in the UK aeronautical information publication in upper airspace.
Upper airspace		Controlled airspace above Flight Level 245 (a nominal altitude of 24,500 feet).
Upper information region	UIR	Flight information region in upper airspace.
Urban air mobility	UAM	See Advanced Air Mobility.
VHF Omni Range and Distance Measuring Equipment	VOR/DME	Combination of two types of radio beacon placed together and used in the UK to provide an en route navigation service.
Visual flight rules	VFR	The rules under which a pilot can fly and navigate an aircraft, in certain weather conditions, by seeing where the aircraft is going.
Visual meteorological conditions	VMC	Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.
VOLMET	VOLMET	Meteorological information for aircraft in flight.