UK Civil Aviation Authority

Concept of Operations – Future Air Traffic Management & Air Navigation Service

CAP 3269

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Acronyms and Abbreviations

Abbreviation	Item
AAM	Advanced Air Mobility
ACP	Airspace Change Proposal
ADS-B	Automatic Dependent Surveillance—Broadcast
AGL	Above Ground Level
AIC	Aeronautical Information Circular
AMC	Acceptable Means of Compliance
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
ARC	Air Risk Class
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
BVLOS	Beyond Visual Line of Sight
C2	Command and Control
C3	Command, Control and Communicate
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CISP	Common Information Service Provider
CAS	Controlled Airspace
ConOps	Concept of Operations

Abbreviation	Item
CTR	Control Zone
CU	Command Unit
DSS	Discovery and Synchronisation Service
DAA	Detect and Avoid
EC	Electronic Conspicuity
Future ATM/ANS	Future Air Traffic Management and Air Navigation Services
FIS-B	Flight Information Service–Broadcast
FUA	Flexible Use of Airspace
GI	Ground Infrastructure
GDPR	General Data Protection Regulation
GM	Guidance Material
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedures
IFR	Instrument Flight Rules
LOS	Line of Sight
MAC	Mid-Air Collision
MLAT	Multilateration
NCSC	National Cyber Security Centre
NHS	National Health Service
NOTAM	Notice to Airmen
OA	Operational Authorisation
RMZ	Radio Mandatory Zone

Abbreviation	Item
RP	Remote Pilot
RPAS	Remotely Piloted Aircraft Systems
RTCA	Radio Technical Commission for Aeronautics
SDSPs	Supplementary Data Service Providers
SERA	Standardised European Rules of the Air
SORA	Specific Operations Risk Assessment
SUA	Special Use Airspace
SWIM	System Wide Information Management
TDA	Temporary Danger Area
TIS-B	Traffic Information Service–Broadcast
TLOS	Target Level of Safety
TMPR	Tactical Mitigation Performance Requirement
TMZ	Transponder Mandatory Zone
TRA	Temporary Reserved Airspace
TSA	Temporary Segregated Area
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAT	Universal Access Transceiver
UTM	Unmanned Aircraft System Traffic Management
VFR	Visual Flight Rules

Executive Summary

Introduction

Within the framework of CAP 1711 Airspace Modernisation Strategy 2023–2040, and particularly its Part 1: Strategic Objectives and Enablers, this document presents the Concept of Operations (ConOps) and associated technical airspace architecture for the Future Air Traffic Management and Air Navigation Services (Future ATM/ANS) programme. The ConOps describes how UK airspace will evolve from today's model, where UAS operations are often managed through segregated airspace arrangements, towards a digitally enabled, integrated airspace ecosystem that can safely accommodate both traditional aviation and new airspace users.

A central aim of this evolution is to enable the UK's Future of Flight vision by setting out the operational, technical and regulatory foundations needed to support emerging aviation use cases at scale. These include:

- Beyond Visual Line of Sight (BVLOS) UAS operations;
- Drone logistics and delivery services;
- Medical and emergency response flights;
- Infrastructure inspection;
- Environmental monitoring;
- Maritime surveillance;
- Autonomous cargo aircraft;
- Advanced air mobility (AAM) passenger services; and
- Future highly automated passenger and freight transport concepts.

The integration of these new entrants into shared airspace is a key objective of both the Airspace Modernisation Strategy (AMS) and the Future of Flight Action Plan. Accordingly, this document focuses on the progressive integration of BVLOS UAS operations approved in the Specific Category, using the UK Specific Operations Risk Assessment (SORA) framework as a pathway towards broader Future of Flight capabilities.

Delivering these use cases requires an airspace environment capable of supporting large numbers of simultaneous operations across multiple sectors and geographic areas. This means moving from today's largely procedural operating model to one that is increasingly digital, automated and interoperable. The Future ATM/ANS programme provides the enabling framework through the coordinated development of policies including Unmanned Traffic Management (UTM), Electronic Conspicuity (EC), Detect and Avoid (DAA), Ground

Infrastructure (GI), Command and Control (C2), and System Wide Information Management (SWIM).

This document is the programme-level integration framework and the authoritative reference for the evolving Future ATM/ANS operating model. It describes how the individual Future ATM/ANS workstreams combine to deliver the services, information exchanges and safety mitigations required to support future airspace users. Together, these capabilities support increasing levels of BVLOS activity and routine commercial drone operations, advanced air mobility networks and other Future of Flight concepts that follow from it.

As an internal reference document for the CAA, the ConOps supports policy and programme development. By publishing it externally, the CAA intends to communicate the programme's operating model, architectural principles and integration pathway to industry, government and other stakeholders. In particular, this ConOps expands upon the operational scenarios described in CAP 3182 (Future of Flight: BVLOS Roadmap) by providing greater technical and operational detail on how these capabilities can be realised through the progressive introduction of new technologies, digital services, automation capabilities and risk mitigations. It also translates Airspace Modernisation Strategy objectives into practical operational concepts and enabling services.

UK airspace is a complex and dynamic environment that must continue to support commercial air transport, general aviation and military operators alongside rapidly emerging Future of Flight participants. Realising the full benefits of Future of Flight therefore requires an airspace architecture capable of supporting high volumes of routine operations while maintaining safety, efficiency and equitable access. For this reason, progress towards integrated airspace operations is achieved through successive iterations of the Future ATM/ANS ConOps and associated technical architecture. This iterative approach, illustrated in Figure 1, supports the testing, validation and assurance of new technologies and operational concepts, ensuring that the architecture evolves in line with the growing requirements of the Future of Flight ecosystem.

ITERATIVE APPROACH

Future ATM/ANS programme objective: to enable more integrated UAS operations by 2027.

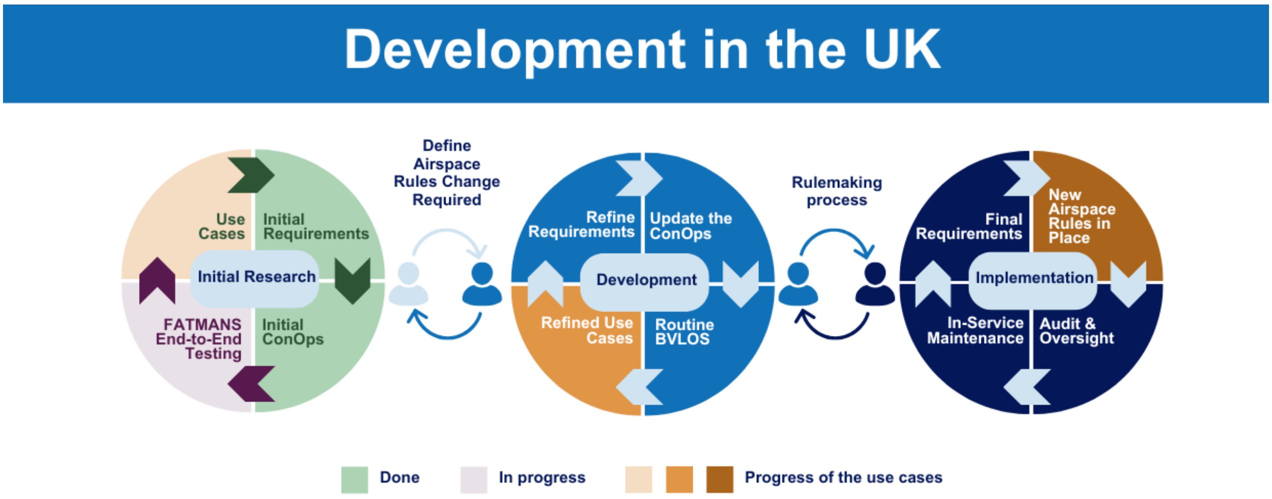

Figure 1. UK CAA Future ATM/ANS ConOps iterative development approach

Future ATM/ANS ConOps – At a Glance

Future ATM/ANS is divided into the following distinct workstreams:

- Electronic Conspicuity (EC)
- Detect and Avoid (DAA)
- Ground Infrastructure (GI)
- Unmanned Aircraft System Traffic Management (UTM)
- Command and Control link (C2)
- System Wide Information Management (SWIM)

This ConOps provides overarching direction for all workstreams across the Future ATM/ANS programme to ensure an aligned solution, enabling safe, efficient and scalable integration of UK airspace. Supporting workstreams, including safety and testing support, are also in place to provide consistent approaches to these critical areas across the programme. Each workstream has an associated ConOps (or equivalent document, such as a Policy Concept) which details, in further depth, the policies and direction relevant to that workstream.

Those documents provide a thorough understanding of how the aims set by this Future ATM/ANS ConOps will be met.

A ConOps is the first step of a broader process for implementing change. The intention of a ConOps is to examine and verify the applicable technology and provide a basis for future implementation work.

Future ATM/ANS is grounded in the UK SORA methodology for UAS integration, resulting in a technical airspace architecture that is modular, risk-based and scalable. Flexibility is key, as future regulatory or guidance releases (e.g. SORA 3.0) are expected to be incorporated within subsequent iterations of the architecture presented here.

The architecture is defined by a structured set of capabilities and interfaces that support a risk-based, interoperable approach to airspace management.

Safety, security and resilience threats, including e.g. GNSS spoofing and jamming, are acknowledged within this ConOps. Further, a detailed assessment of possible threats and risks to the architecture is planned for completion once the baseline architecture is agreed upon (this release of the ConOps).

Next Steps

The operationalisation of the ConOps and the associated architecture follows a sequenced approach:

- Short-Term: Iterative development of individual policy concepts and/or technical documentation across the EC, DAA, GI, UTM, C2 workstreams. This includes the collection of learnings from testing activities.
- Medium-Term: Execution of the Future ATM/ANS holistic testing programme, combining different elements from individual workstreams into progressively more complex operational scenarios based around ARCs.
- Long-Term: Publish the final version of each policy that supports the UK SORA methodology, enabling flight operations in a 'business as usual' manner.

Progressive improvement in the level of integration will make UAS operations scalable and adaptable to evolving technological and operational requirements. This architecture supports the AMS's overarching goals and ensures the UK remains a global leader in airspace innovation and safety.

Chapter 1
Introduction

1.1 This ConOps sets out a framework for the integration of new entrants into UK airspace, emphasising risk-based decision-making, interoperability among UAS, UTM, and ATM systems, and equitable access for all airspace users. It supports the CAA's strategic roadmap to iteratively transition from segregated to fully integrated airspace operations.

1.2 At present, the UK CAA enables BVLOS UAS operations, outside of Atypical Air Environments (AAE),[1] primarily within segregated airspace. While this strategy has proven effective in the short term for enabling trials and testing only, it is increasingly evident that, from a safety perspective, it lacks scalability. The implementation of segregated airspace, even temporary, presents a barrier to other airspace users and is a limiting factor in transitioning from trials to widespread operations. In response, the CAA's Airspace Modernisation Strategy (AMS) has established a forward-looking vision and objectives to modernise UK airspace. This strategy seeks to foster greater integration of diverse airspace users, with a specific ambition to enable routine integrated BVLOS UAS operations by 2027. The integration of BVLOS UAS operations is further detailed in the CAP 3182 BVLOS roadmap. This may include simultaneous flights conducted by one or more UAS operators in airspace that is also available to other airspace users.

1.3 Technological developments, including DAA capabilities and the use of UTM service provision, are intended to supplement and, where appropriate, progressively replace certain segregation-based mitigations while maintaining or improving safety performance.

Scope

1.4 This release of the ConOps sets out a framework for the holistic testing of the Future ATM/ANS technical architecture. It describes operational scenarios derived from the Future of Flight BVLOS Roadmap[2] and provides a framework for their progressive operationalisation. In this ConOps, in this ConOps, UK SORA is used to describe the relevant strategic and tactical mitigations. Future iterations of this ConOps will gradually incorporate additional stakeholders, including those involved in certified operations, such as AAM (Advanced Air Mobility) operations, where the SORA methodology may not be applicable. It will

[1] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[2] CAP3182 UK CAA Future of Flight: BVLOS Roadmap

also incorporate changes that result from updated guidance (e.g. SORA 3.0). These updates will ensure a comprehensive and adaptable framework that continues to meet the evolving needs of all airspace users.

Objectives

1.5 The vision outlined in this ConOps is to establish a future airspace system that is digitally enabled, resilient, and capable of supporting all airspace users. This vision emphasises the use of automation, quantitative risk-based decision-making, and advanced surveillance technologies to improve situational awareness and conflict management. The ConOps also reinforces the importance of a collaborative approach involving key stakeholders such as Air Navigation Service Providers (ANSPs), UAS operators, other airspace users, and industry bodies in developing and validating operational concepts.

1.6 Safety remains the highest priority in the integration process. This ConOps adopts a quantitative risk-based approach initially using the UK SORA framework to manage air risk effectively. This includes leveraging advanced technologies such as DAA systems, EC and improved ATM surveillance capabilities to strategically and tactically mitigate mid-air collision risks. Key safety objectives include:

- Understanding the likelihood of mid-air collisions (MAC): The ability to characterise the airspace and to ensure that mitigations are sufficient to reduce the residual risk to an acceptable level.
- Risk-based Mitigation Strategies: The ability to combine procedural and technical mitigations in a manner proportional to the air risk.
- Continuous Air Risk Monitoring: Implementing ongoing risk assessments and audits by the CAA to ensure that changes to air risk are assessed and understood.

1.7 The ConOps envisions a scalable and flexible airspace management system capable of supporting the growth of UAS traffic and leveraging new technologies, which include the following objectives:

- Reduction in Airspace Fragmentation: Evolving from operator-requested Special Use Airspace (SUA) to risk-based services in place to reduce areas of segregated airspace with clear benefits for all airspace users.
- Phased Integration Roadmap: Implementing a staged approach to integration based on the SORA framework and the findings of the Air Risk Studies carried out as part of the EC project (UK CAA CAP3139 on Electronic Conspicuity (EC) Consolidated Study Report) and future iterations.

- Flexible and Dynamic Airspace Integration Concept: The use of segregated airspace structures, should be minimised and progressively reduced as a long-term operational dependency. Instead, airspace should be managed through a flexible, risk-based and dynamically coordinated approach that enables the safe coexistence of manned and unmanned traffic within shared airspace volumes. Any required segregation should therefore be temporary, operationally justified and limited to specific time periods or high-risk activities, while the primary operational model should rely on advanced tactical mitigations and digital integration capabilities, including Electronic Conspicuity (EC), Detect and Avoid (DAA), UTM services, SWIM-enabled information exchange and dynamic airspace management. This approach enables a phased transition from segregated BVLOS operations, via the accommodation of operations in structured airspace, towards routine, scalable integration within UK airspace.

1.8 Achieving seamless integration between UAS operations and existing ATM systems is a core objective of the ConOps. This involves:

- Standardised Data Exchange: Defining common data exchange protocols to facilitate real-time information sharing between UTM and ATM systems, in line with SWIM principles.
- Harmonisation with evolving International Standards: Ensuring that integration efforts align with International Civil Aviation Organization (ICAO) standards and international best practices where appropriate.
- Cooperative Traffic Management: Leveraging EC capabilities through the integration and implementation of GI to support cooperative traffic management solutions for BVLOS operations.

1.9 The ConOps envisions a future where UAS operate safely and efficiently alongside manned aviation in a fully integrated UK airspace. This vision includes:

- Digitally Enabled Airspace Management: Utilising automation, data-driven decision-making, and advanced surveillance technologies to enhance situational awareness and conflict management.
- Innovative Mitigation Solutions: Exploring new mitigation measures, such as EC-based avoidance systems and enhanced tactical mitigations, to address residual risks effectively.
- Leading in Global Airspace Integration: Establishing the UK as a leader in the safe and sustainable integration of unmanned aviation through proactive policymaking and international collaboration.

Chapter 2

Airspace Operational Concept

2.1 This chapter sets out the strategic view on the operational concept to progressively integrate new entrants while minimising airspace fragmentation, with an initial focus on UAS operations.

Description of the Operational Environment

2.2 The classification of airspace remains a foundational element for ensuring safe and efficient aviation operations. As defined by the International Civil Aviation Organisation (ICAO[3]), States determine the need for the provision of Air Traffic Services (ATS) – i.e. Air Traffic Control (ATC) service, Flight Information Service (FIS) and alerting service – and then classify and designate the airspace accordingly. The United Kingdom has implemented the ICAO airspace classification framework through the Standardised European Rules of the Air (SERA). UAS operations are not classified as either VFR or IFR. In the UK, they are generally subject to the same SERA Right-of-way[4] or Flight Priority,[5] in controlled airspace, already in place for manned aviation.

2.3 UK SORA has been adopted as the risk-based methodology relevant to BVLOS operations. Among its innovative contributions, this approach introduces Air Risk Class (ARC), which may complement existing airspace classifications. ARC designates volumes within existing airspace classes according to assessed risk levels, ranging from 'a' (lowest) to 'd' (highest). These risk levels may be determined either qualitatively or quantitatively[6] through detailed airspace characterisation studies.[7] By integrating ARC assessments with existing airspace classifications using a matrix-based approach, operational structures are informed by risk exposure, rather than relying exclusively on historical classifications.

[3] ICAO Annex 11 (ref. Fig. 2)

[4] SERA.3210 — Right-of-way

[5] UK CAA, Manual of Air Traffic Services – Part 1 (CAP 493), Section 1, Chapter 4: Control of Traffic, paragraph 10. Flight Priorities.

[6] Quantitative analysis methods are under development within JARUS SORA 3.0. While these methods are not currently available for use within the UK SORA framework, they are included here for consideration in the definition of this approach.

[7] UK Regulation 2019/947 Annex C Paragraphs 1.53-1.61

2.4 The Residual ARC is the final classification of mid-air collision risk between a UA and manned aircraft, determined after applying strategic mitigations to the initial air risk. The ARCs are defined in the UK SORA as follows:

- Residual ARC-a: The encounter rate with other manned air traffic is demonstrated to be negligible; therefore, DAA-based tactical mitigation of the air risk is not required.
- Residual ARC-b: Encounter rate with other manned air traffic demonstrated to be low and exclusively Type-1,[8] but not negligible. DAA-based tactical mitigation is therefore required and must be supported by one or more additional strategic mitigation layers.
- Residual ARC-c: Predominately Type-1 traffic and negligible commercial air transport aircraft, with either an encounter rate that cannot be demonstrated to be low enough for ARC-b or additional supporting strategic mitigations are unavailable. DAA-based tactical mitigation is therefore required and expected to be used routinely rather than occasionally.
- Residual ARC-d: Predominantly Type-2[9] traffic, therefore subject to the highest level of tactical mitigation due to the highest severity consequence and the highest safety standard airspace. Specific category UAS operations are likely to only be by exception (e.g. via a certified DAA system) for this ARC.

2.5 The proposed holistic testing approach to iteratively develop the Future ATM/ANS framework will consider a residual ARC up to ARC-c. The goal of this strategy is to show an option for avoiding segregation as a way of achieving the required level of safety (managing the risk of Mid-Air Collision) for BVLOS operations, ensuring that:

- DAA capabilities are in place where required.
- It is possible to control the encounter rate under self-separation and see-and-avoid (Type 1).

Technology in Support of UK SORA

2.6 The introduction of the UK SORA establishes clear and precise expectations for how operations are defined and conducted across the four designated ARCs. While the Future ATM/ANS programme may not address every element required

[8] Type-1: Operations primarily conducted under self-separation and see-and-avoid (primarily in uncontrolled airspace). UK SORA, Step 4, Paragraph 2.37.

[9] Type-2: Operations that occur with separation provided by an ANSP (primarily in controlled airspace). UK SORA, Step 4, Paragraph 2.37.

by the SORA air risk framework, it offers guidance on the recommended approach to many of these aspects. In particular:

- The Airspace Characterisation
- Strategic Mitigations (SM) to reduce the ARC
  - Relevant to the Future ATM/ANS programme are the following mitigations:[10]
    - SM4 & SM5 – SUA and Other Airspace Requirements: This set of mitigations describes the establishment of specific areas of operation in accordance with CAP 1616 and their promulgation in the Aeronautical Information Publication.
    - SM6 – Pre-agreement of any ANSP service to be used in flight: These mitigations describe coordination with ANSP. Depending on the nature of the services provided, this may contribute to a reduction of the ARC.
    - SM7 – Pre-agreement of any UTM services to be used in-flight
- Tactical Mitigations (TM)[11]
  - Relevant to the Future ATM/ANS programme are the following mitigations:
    - TM2 – DAA Capability
    - TM3 – Carriage of EC Out
    - TM4 – Monitoring of VHF Radio
    - TM5 – Monitoring local cooperative traffic

2.7 The pathway to expanding the number of Operational Authorisations in the UK under the UK SORA framework and to support the holistic testing of the technical architecture hinges on the capacity of the Future ATM/ANS programme to articulate relevant Acceptable Means of Compliance (AMC) or Guidance Material (GM). This will describe how operators can leverage the programme's technologies to secure Operational Authorisations. Reducing dependence on SUAs, along with the associated airspace design changes, is a key objective that will contribute to the overarching aim of integrating all airspace users.

2.8 A key objective of the Future ATM/ANS programme is to remove regulatory blockers and define approval pathways for BVLOS operations and integration of all airspace users. It is critical that all individual Future ATM/ANS project-level ConOps explicitly incorporate a robust demonstration of how they will mitigate air risk. Specifically, these ConOps must articulate the role of relevant technologies

[10] Extracted from UK SORA Annex C – refer to this annex for a full list of mitigations

[11] Extracted from UK SORA Annex D – refer to this annex for a full list of mitigations

as effective strategic or tactical mitigations within the UK SORA air risk framework.

Airspace Characterisation

2.9 A UK air risk study, as captured under the Collision Risk Assessment & Mitigation Support (CRAMS) [12] technical workstream, is underway. This is complementary to CAP3139 on Electronic Conspicuity (EC) Consolidated Study Report. Its objective is to provide a representative example of how quantitative, encounter-based assessment of unmitigated air risk can be performed across selected UK airspace regions. The study establishes a methodological basis to characterise airspace risk and to explore the relative impact of strategic and tactical mitigations in achieving target levels of safety. Within the CRAMS framework, this supports the consistent interpretation of airspace risk in relation to ARC allocation. However, in the absence of an agreed policy linking quantitative air risk characterisation to ARC definitions, and without broader application across UK airspace, it is not yet possible to derive nationally applicable ARC interpretations or equivalent air risk representations for UAS operators. Establishing a robust relationship between quantitative residual risk and ARC classification remains a key enabler for future implementation and is anticipated to evolve in line with SORA 3.0 developments.

2.10 Within the CRAMS workstream, quantitative airspace characterisation is supported using available air traffic data. This is supplemented where necessary by data augmentation techniques and modelling assumptions to address limitations in coverage, completeness, or representativeness.

Strategic Mitigations

2.11 SM4 & SM5 – SUA and Other Airspace Requirements

- These mitigation measures are employed today to facilitate trials and sandboxes within UK airspace. Typically, they are sought by individual operators as part of Operational Authorisations through varied mechanisms utilising the ACP process and AIC/NOTAMs, e.g. establishing a Temporary Danger Area (TDA). These measures prove highly effective due to their capacity to effectively isolate UAS operations from other air traffic. However, they present certain drawbacks, such as their implementation is often time-intensive and contributes to airspace fragmentation, which may disadvantage other airspace users.

[12] UK Civil Aviation Authority - Collision Risk Assessment & Mitigation Support Initial Concept of Operations.

- As the quantity of UAS traffic grows across the UK, there is a risk of constraining further scalability. Nonetheless, arrangements providing increased access are often employed to minimise impact and maintain balanced use of the airspace. In summary, permanent or long-term airspace change to allow integrated use of airspace is a positive outcome, compared to the temporary nature of segregating airspace.

2.12 SM6 – Pre-agreement of any ANSP services to be used in-flight

- These mitigation measures may be utilised to facilitate individual operations, particularly where accommodation by ANSP is coordinated on a case-by-case basis. While such arrangements may prove valuable for specific instances, they are not conducive to supporting scaled operations without the backing of a UTM system. Consequently, their relevance within the broader scope of this ConOps remains limited, unless fully digitised and integrated, as they lack the systemic framework required to efficiently accommodate the growing volume and complexity of new entrant activities in UK airspace.

2.13 SM7 – Pre-arrangement of any UTM services to be used in flight

- UK SORA acknowledges UTM systems as a strategic mitigation for reducing the Air Risk Category (ARC). As a digital and automated tool, UTM should provide strategic and tactical capabilities – such as Geo-consciousness, UAS Flight Authorisation, and Conflict Management services. These have been explored in various international contexts and are detailed further in the UTM ConOps.

- Comprehensive testing of the UTM ConOps is essential for this mitigation to be effectively implemented. The testing aims to prove how operations in both controlled and uncontrolled airspace, and expanding across all ARC levels, could benefit from UTM. Key factors for this testing include traffic volume, operational complexity, and local considerations such as the availability of GI. Rather than segregating UAS operations, the UK focuses on integration, ensuring UTM supports a shared airspace environment. Testing activities will inform clear guidelines for operators to work with UTM service providers, detailing standards for data exchange, communication protocols, and the validation of mitigation performance.

Tactical Mitigations

2.14 TM2 – DAA Capability

- For UAS to integrate with other aircraft, the requirement for a DAA system is crucial. The CAA has published the CAP 3015 DAA Policy Concept and CAP 722 Unmanned Aircraft System Operations in UK Airspace – Policy and Guidance, Chapter Four, which guides the utilisation of this technology in the context of a UK SORA authorisation.

2.15 TM3 – Carriage of EC Out

- The carriage of EC Out is essential to ensure the conspicuity of UAS when required. However, it is of limited value without the ability to receive it (either in the air or on the ground). This mitigation is, therefore, intended as part of a broader system to be defined and tested as part of the overall Future ATM/ANS ConOps, in line with CAP3140.

2.16 TM4 – Monitoring of VHF Radio

- This mitigation requires UAS remote pilots in command to be in the range of their operations since the mitigation's intent is to actively listen on VHF communications in the vicinity of the operations. Hence, this mitigation is not considered for BVLOS operations under this assessment due to the low level of mitigation which is provided.

2.17 TM5 – Monitoring Local Cooperative Traffic

- Monitoring of local cooperative traffic can be achieved either air-to-air, with intelligent use of EC, or on the ground, with GI and UTM support.

2.18 In general, to achieve the Tactical Mitigation Performance (TMPR) required by the SORA across different airspace volumes, classes, and ARC, the precise role of EC, UTM and DAA and their complementary technical enablers (C2 and GI) as tactical mitigations must be explored.

Architecture & Infrastructure

Technical Airspace Architecture

2.19 The technical airspace architecture for the Future ATM/ANS ConOps progresses in line with CAP3182 (Future of Flight: BVLOS Roadmap). This provides a pathway towards full integration of unmanned aircraft systems within UK airspace.

2.20 Ultimately, BVLOS UAS operations will require an infrastructure enabling safe and routine integration. The main objective of this section is to present an architecture that considers the complete set of necessary components, from digital to physical infrastructure, as shown in Figure 2.

EXAMPLE ARCHITECTURE FOR FUTURE UAS INTEGRATION

Enabling fully integrated UAS operations in UK airspace

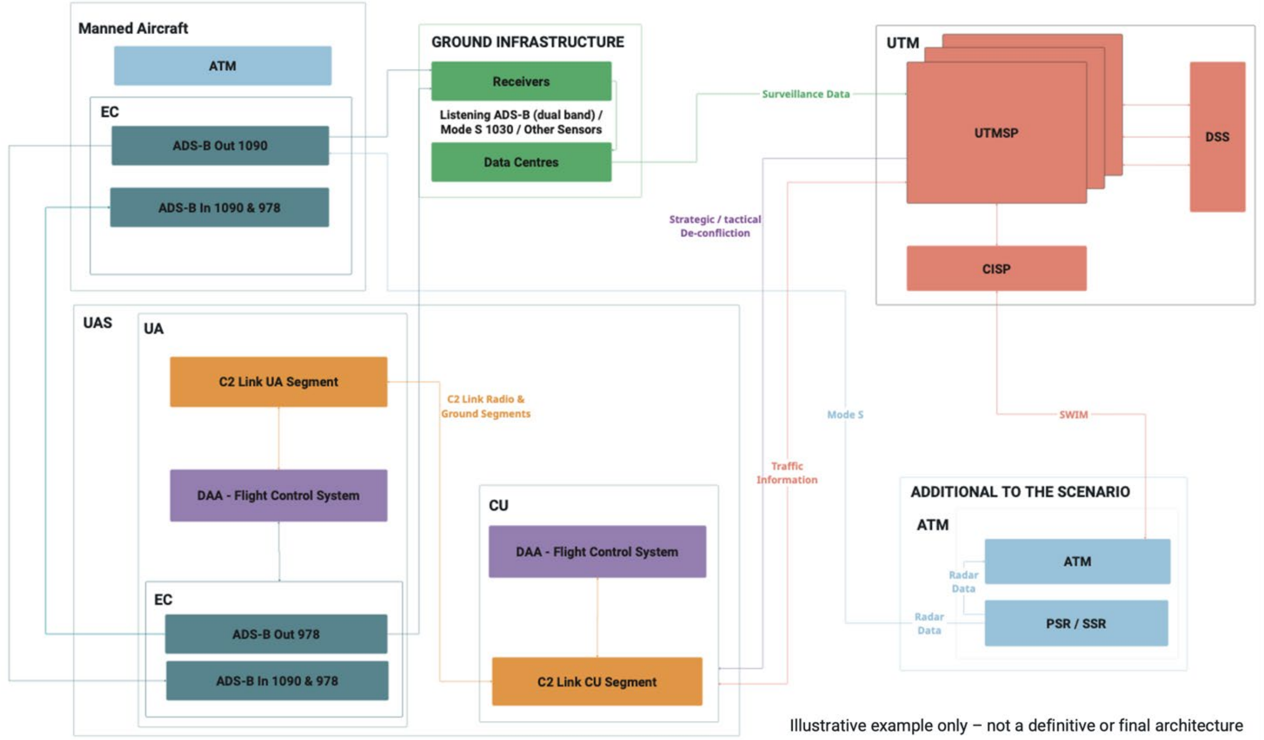

Figure 2. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

2.21 The proposed progression timeline considers a set of three periods starting from now towards a full integration concept beyond 2028, aligned with CAP3182. These can be categorised as:

- Period 0, now;
- Period 1, which covers 2027 and 2028; and
- Period 2 beyond 2028.

2.22 These time periods encompass the full roadmap - from Atypical Air Environment scenario A0, aligned with Period 0, to Fully Integrated scenario FI3, aligned with Period 2. This progression timeline allows:

- Phased Integration Approach: Facilitating a gradual transition from less risky environments to full integration with traditional ATM systems, where the validation of new technologies and operational concepts, such as providing UTM services,[13] minimises risks and ensures continuous compliance with the AMS.

[13] Further detail will be available in the UTM ConOps.

- Risk-Based Management Using SORA: A core feature of the architecture is its alignment with the UK SORA methodology, which provides a risk-based approach to UAS operations. Primarily, it provides an assessment of air and ground risk. It includes the mitigation measures, both strategic and tactical, such as EC and DAA systems, that are deployed to meet Target Levels of Safety (TLOS).
- Comprehensive Surveillance Integration: The architecture integrates multiple surveillance technologies, including ADS-B, MLAT, and PSR/SSR. Surveillance data could be fused, providing a comprehensive air picture that enhances situational awareness for UAS operators and traditional ATM systems.
- Advanced C2 Link Capabilities: C2 Link capabilities evolve along with the maturity of the integration of the architecture, starting with secure communications, advancing to multi-path, redundant C2 Link with automatic connection switching capabilities. This progression ensures reliable communications for both VLOS and BVLOS operations, maintaining control integrity across different airspace environments.
- DAA System: In alignment with CAP3015 and DAA capabilities associated with ARC-b, ARC-c and ARC-d, the required DAA capabilities will be progressively integrated. This evolution supports remaining well clear and collision avoidance in increasingly complex and congested airspace, ensuring compliance with manned aviation standards.
- Modular and Scalable Design: The architecture's modular design allows for the integration of new capabilities and technologies without requiring extensive reconfiguration. This flexibility ensures that the airspace systems can scale efficiently to accommodate the growing number of UAS operations and evolving technological advancements.

Key Architectural Elements

2.23 Electronic Conspicuity (EC)

- Full implementation of ADS-B In/Out across 1090MHz / 978 MHz will increase the visibility and likelihood of UAS by all airspace users, as well as provide a complete situational awareness picture for unmanned aircraft.
- Real-time data sharing of EC information with multiple UTM service providers for enhanced situational awareness.

2.24 C2 Link Infrastructure

- Integration of C2 Link systems with automated failover capabilities to support complex operations, including BVLOS in high-density airspace.

- Use of authenticated, secure, and redundant C2 paths, incorporating multiple terrestrial and/or satellite-based communication systems.

2.25 DAA for Integrated Airspace

- Full DAA capabilities, not only to provide situational awareness but also to include the use of predictive conflict detection and automated avoidance manoeuvres, fulfilling integrity and assurance levels comparable with ACAS-Xa.

2.26 UTM and ATM Integration

- Multiple UTM service providers are established with standardised data exchange protocols enabling real-time coordination of UAS operations through the Discovery and Synchronisation Service (DSS).
- Integration of UTM data with ATM systems, which may include military ATM (noting defence/security considerations). Expected to be enabled via CISP,[14] to ensure synchronised traffic management across all airspace classes.

2.27 Dynamic Airspace Management

- The dynamic management of airspace is supported by the SWIM[15] standard requirements for secure and efficient data exchange between ATM and UTM.

2.28 Advanced Surveillance and Data Fusion

- Data received from ADS-B, MLAT, PSR/SSR, and EC beacons are integrated for real-time traffic management.
- Use of standardised protocols for comprehensive surveillance and data interoperability.
- Surveillance data is utilised by both UTM and ATM systems as available and applicable, for comprehensive conflict management, contingency and emergency procedures.

2.29 The proposed architecture enables UAS to operate safely in all airspace environments, achieving full integration with traditional manned aviation systems. The architecture supports high-density UAS operations by leveraging advanced automation, secure real-time data exchange, and predictive conflict management to enhance situational awareness and maintain safe separation.

[14] Further detail will be available in CISP ConOps.

[15] Further detail will be available in SWIM ConOps.

Infrastructure

2.30 The infrastructure supporting the proposed UK airspace integration strategy is a comprehensive system that combines physical and digital elements to enable the safe, scalable, and efficient integration of UAS and AAM[16] operations. It encompasses ground-based networks, onboard equipment, and advanced information management systems to ensure seamless interaction between UAS operators, UTMSPs, traditional ATM systems, regulatory authorities, and supplementary data service providers (SDSPs).

2.31 The architecture's design is based on a decentralised and distributed model, which allows multiple independent actors to collaborate effectively within a harmonised ecosystem. This approach supports a risk-based, interoperable, and adaptive airspace management strategy aligned with the AMS and the UK SORA framework.

Onboard Equipment

2.32 Onboard equipment is a critical component of the proposed architecture, providing the necessary capabilities for UAS to operate safely and effectively in both segregated and integrated airspace environments. The onboard systems should be based on standards to ensure compatibility and interoperability with ground-based systems and other airspace users.

2.33 EC systems are essential for making UAS visible to other airspace users and for enabling UAS to detect, and be detected by, other aircraft.

- ADS-B Out: UAS are equipped with ADS-B Out capabilities on 978 MHz frequencies, enabling them to broadcast their position, velocity, and optional trajectory intent information to other UAS, manned aircraft equipped with ADS-B In dual-band, and both UTM and ATM systems. This ensures that UAS are visible to other airspace users, including manned aircraft.
- ADS-B In: UAS also integrate ADS-B In receivers on 1090 MHz and 978 MHz frequencies to collect traffic information from nearby manned and unmanned aircraft, as well as traffic from TIS-B, when provided. This capability enhances situational awareness and supports onboard DAA functions.
- Compliance Standards: All EC systems comply with Radio Technical Commission for Aeronautics (RTCA) DO-260C (1090MHz) and DO-282C (978 MHz) standards, ensuring interoperability and consistent performance across different airspace classes, when required.

[16] AAM: new ways of moving people and goods within urban areas and between regional ones — using innovative aircraft such as electric Vertical Take-off and Landing (eVTOL).

2.34 C2 Link systems are vital for maintaining communication between the UAS and its control unit, ensuring that operators can manage UAS operations safely and efficiently.

- C2 Link Capabilities: UAS are equipped with one or more radio connections, such as terrestrial (4G/5G) and/or satellite-based C2 Link to provide continuous communication in both VLOS and BVLOS scenarios. These links support command inputs, telemetry, and system status updates.
- EASA MOC for Command, Control and Communicate (C3) links, applied proportionally for low SAIL levels. This ensures secure and reliable data transmission. The architecture also supports multiple C2 Link pathways to enhance redundancy and prevent communication loss.
- Standardised Protocols in complex use cases: C2 Link data exchange, ensuring interoperability with ground-based systems and facilitating real-time control.
- Cybersecurity Measures: C2 Link systems incorporate encryption and authentication protocols to safeguard against unauthorised access and data breaches, ensuring that communications between UAS and control units remain secure where the C2 Link is carried over the internet:
  - The primary ISP connection at the RPS should follow Ofcom's recommended code of practice for business broadband services, which covers data rate.
  - The Command Unit (CU) implementation should follow the UK's National Cyber Security Centre (NCSC), which provides advice and guidance on different aspects of cyber security, covering devices, networks, and different deployment scales.

2.35 DAA Systems are a key component that allow UAS to maintain situational awareness of surrounding traffic and to detect and mitigate potential conflicts with other airspace users.

- DAA Capabilities: UAS are equipped with DAA systems, which integrate data from ADS-B In, onboard radar (if available), and other sensors to detect nearby traffic and execute avoidance manoeuvres if necessary.
- Integrated Situational Awareness: DAA systems provide real-time situational awareness by fusing data from multiple sources, including ADS-B, MLAT, and onboard sensors. This ensures that UAS can detect potential conflicts early and respond appropriately.
- Predictive Conflict Detection: DAA capabilities include predictive conflict detection, which assesses potential risks based on trajectory predictions to initiate avoidance actions if required.

2.36 Surveillance and Navigation Systems ensure that UAS can operate accurately and safely across different airspace classes.

- Global Navigation Satellite Systems (GNSS): UAS are equipped with GNSS-based navigation systems for precise geolocation and flight path management, supporting both EC and DAA functions.
- Barometric and Inertial Sensors: Optional onboard barometric and inertial measurement units (IMUs) enhance altitude and position accuracy.
- Air Data Sensors: These sensors measure barometric data (converted to altitude and airspeed after processing) and external air temperature, contributing to flight control and performance monitoring.
- Magnetometers (Digital Compasses): Measure Earth's magnetic field to assist in navigation, especially in environments where GNSS signals may be unreliable.
- Optical and Imaging Sensors: Potential inclusion of cameras and LiDAR systems that capture visual data for terrain mapping, obstacle detection, and enhanced situational awareness.
- Integration with Ground-Based Surveillance: Onboard systems are designed to integrate seamlessly with ground-based surveillance systems such as ADS-B, MLAT, and radar, providing a unified air picture for both UTM and ATM.

Physical Infrastructure

2.37 The physical infrastructure complements the onboard systems by providing the necessary ground-based facilities to support surveillance, communication, and data management.

- Communication Networks: High-capacity terrestrial networks (4G/5G), satellite communication and Internet Service Providers (ISPs) ensure reliable C2 Link and support real-time data exchange between UAS, UTMSPs, and ATM systems.
- Surveillance Systems: Ground-based ADS-B receivers, MLAT systems, and radar provide comprehensive surveillance coverage, improving situational awareness and supporting strategic deconfliction.
- Possible use of Decentralised Data Centres: Distributed data centres and edge computing nodes process surveillance and operational data, supporting real-time decision-making and scalability.

Digital Infrastructure

2.38 The digital infrastructure facilitates seamless data exchange between UAS, UTM, and ATM systems through standardised protocols and advanced information management systems.

- Common Information Service Provider (CISP).[17] CISP acts as an intermediary between the ATM and the UTM, ensuring standardised data sharing and the dissemination of traffic information.
- Distributed UTM Platforms:[18] Multiple UTMSPs operate simultaneously, providing services such as flight approvals, strategic deconfliction, and compliance monitoring, all integrated with ATM systems.
- Supplementary Data Service Provider (SDSP): SDSPs provide operational data, including weather updates and terrain information, directly to UAS and UTMSPs, enhancing safety and decision-making.

Operational Advantages

2.39 The integration of advanced onboard equipment and Ground Infrastructure provides several key advantages:

- Enhanced Situational Awareness: The use of ADS-B In/Out, DAA, and integrated surveillance systems ensures that UAS have comprehensive situational awareness, reducing collision risks.
- Interoperability: The use of standardised protocols ensures that all onboard and ground-based systems can operate harmoniously.
- Scalability and Flexibility: The modular design of the infrastructure allows for simpler scaling of UAS operations without significant modifications to existing systems.

Challenges

2.40 Despite its strengths, the proposed infrastructure presents several challenges:

- Coordination Complexity: Managing data exchange among multiple UTMSPs, ATM systems, and onboard systems can introduce operational complexities.
- Cybersecurity Risks: The distributed nature of the infrastructure necessitates robust cybersecurity measures to protect the C2 Link and surveillance data from potential threats.
- Compliance and Standardisation: Ensuring that all onboard equipment complies with national and international standards requires continuous monitoring and validation.
- Surveillance Infrastructure Gaps: There is currently no nationwide GI for 978 MHz or TIS-B in the UK, raising questions around funding, deployment responsibility, and long-term sustainability.

[17] Further details will be available in the CISP ConOps.

[18] Further details will be available in the UTM ConOps.

- Data Sharing and Interoperability: Achieving seamless interoperability between stakeholders remains challenging, particularly where ANSPs have competing interests or co-ownership structures. Issues related to data ownership, access rights, and the exchange of potentially proprietary information may significantly hinder integration.
- Standards Maturity: There is presently no established ASTERIX category or fully defined standards for Universal Access Transceivers (UAT) applicable to the UK context, which limits harmonised implementation and integration into existing ATM systems.
- Positioning, Navigation, and Timing: The architecture does not currently address resilience in Positioning, Navigation, and Timing (PNT), particularly in scenarios involving GNSS interference (intentional or unintentional), which represents a critical operational vulnerability.

2.41 The integration of advanced onboard equipment with a comprehensive Ground Infrastructure provides a robust framework for managing UAS operations in UK airspace. This architecture lays the foundation for achieving safe and efficient integration of new entrants into the national airspace by ensuring interoperability, scalability, and enhanced situational awareness. Addressing challenges such as cybersecurity, coordination complexity, and regulatory compliance will be essential to realising the full potential of this infrastructure.

Chapter 3

Use Cases and Example Scenarios

3.1 This ConOps defines a set of operational use cases and example scenarios to support the progressive integration of BVLOS UAS operations within UK airspace. The scenarios aim to illustrate how the BVLOS roadmap can be realised through practical examples. These scenarios are intended to be progressively tested, with insights from each scenario informing subsequent development and supporting validation of the proposed Future ATM/ANS architecture through end-to-end testing.

3.2 The scenarios represent a stepwise evolution towards increased integration of BVLOS operations conducted under the specific category, leveraging the UK SORA framework. Initial scenarios focus on lower air risk environments, with complexity increasing as integration mechanisms, services, and procedures mature.

Future of Flight: BVLOS Roadmap CAP3182

3.3 The CAP3182 roadmap, published in October 2025, outlines the UK CAA plan to enable routine BVLOS drone operations in the UK by 2027/2028 and beyond. This is included here as Figure 3, wherein the roadmap utilises an iterative approach, moving from segregated airspace to full integration to unlock the economic and societal potential of UAS.

3.4 The CAA has identified three primary BVLOS pathways based on industry demand and regulatory approach:

- Atypical Air Environment (AAE)[19]
- Integrated low-level BVLOS over an urban area
- Fully integrated BVLOS

Atypical Air Environment (AAE)

3.5 An operationally defined volume of airspace in close proximity to specific fixed infrastructure, within which it can be demonstrated, through airspace characterisation and supporting evidence, that the likelihood of encounters with conventionally piloted aircraft is very low.

3.6 An AAE is not a separate class of airspace and may exist within any ICAO airspace class. Its designation is specific to the location, operating context, and

[19] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

supporting mitigations, and does not imply permanent or exclusive use. AAE operations typically support BVLOS activities near fixed infrastructure, including linear infrastructure inspection (e.g. railways, power lines, roads), wind turbine surveys, agricultural operations, and security or perimeter patrols. These operations align with the Atypical operational[20] pathway described in CAP3182[21] and are generally associated with residual air risk consistent with ARC-a, subject to ongoing review as operational experience and policy mature.

Integrated Low Level Urban (LL)

3.7 A low-level urban environment is an operationally defined volume of airspace, typically below 500 ft AGL, located over or within populated areas, in which BVLOS UAS operations are conducted alongside other airspace users.

3.8 Operations in this environment are characterised by higher traffic density, increased ground risk, and the potential presence of low-level crewed aviation, including emergency air services and general aviation.

3.9 This environment is not a separate airspace class and may exist within both controlled and uncontrolled airspace. Operations are enabled through a combination of airspace characterisation, strategic and tactical mitigations, and increasing reliance on technical enablers such as Electronic Conspicuity (EC), Detect and Avoid (DAA), UTM services, and supporting Ground Infrastructure.

3.10 Low-Level Urban operations typically support use cases such as last-mile delivery, medical logistics between healthcare facilities, and urban inspection activities. As described in CAP3182, this pathway represents a progressive transition from operations reliant on bespoke access conditions or temporary airspace structures toward routine, scalable BVLOS operations integrated with other airspace users, with residual air risk evolving from ARC-a toward ARC-b or ARC-c as integration matures.

Fully Integrated (FI) BVLOS

3.11 A Fully Integrated Environment refers to airspace in which BVLOS UAS operations are conducted routinely alongside conventionally piloted aircraft across a wide range of altitudes, airspace classes, and traffic densities.

3.12 In this environment, UAS are treated as full participants in the airspace system, operating under integrated airspace management principles rather than segregation or bespoke access arrangements.

3.13 This environment is not defined by airspace classification alone and may exist within both controlled and uncontrolled airspace. Safe operation is enabled

[20] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[21] CAP3182 UK CAA Future of Flight: BVLOS Roadmap

through a mature, interoperable ecosystem incorporating high-assurance DAA capabilities, mandated EC equipage, resilient Command and Control (C2) links, comprehensive Ground Infrastructure, and real-time coordination between UTM and ATM systems, including SWIM-enabled information exchange where applicable.

3.14 Fully Integrated operations support complex and time-critical use cases such as emergency air services support, offshore and remote asset inspection, and middle-mile logistics. As set out in CAP3182, this pathway represents the highest level of operational maturity, complexity and risk. In these scenarios, residual air risk is managed dynamically through systemic integration rather than airspace restrictions, enabling scalable BVLOS operations across the UK airspace system.

Timeline of Operational Maturity

3.15 Today (Current Scenarios 2025–2026): Routine BVLOS is currently possible under the Atypical Air Environment (AAE) policy concept[22] or through bespoke UK SORA safety cases. More specifically:

- Atypical (A0): Single-operator flights within an AAE, such as railway inspections or perimeter patrols.
- Low Level (LL0) & Integrated (FI0/FI1): Operations are largely limited to segregated volumes like TDA and/or TRA and Transponder Mandatory Zones (TMZ) with bespoke entry conditions.
- Operations are typically ARC-a, requiring no formal Detect and Avoid (DAA) and relying on Procedural/Electronic Conspicuity (EC) observation.

3.16 Near Future (Scalable Operations 2026–2027): Operations will transition toward multi-operator environments, enabled by UK SORA and enhanced by the Future ATM/ANS architecture, up to residual ARC-b:

- Atypical (A1): Multiple operators can share the same AAE volume through UTM-enabled flight planning and strategic deconfliction.
- Integrated (LL1/FI2): Routine operations will begin in controlled airspace, reducing reliance on temporary structures.
- Residual ARC-b: Scenarios move toward ARC-b, requiring approved DAA solutions and standardised ATC procedures.

[22] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

3.17 Long-Term: High-Risk Environments (2028+): The focus shifts to operational examples in high-risk environments with residual ARC-c or ARC-d, only possible in the long-term and requiring mature, highly integrated systems:

- Scenarios (LL2/FI3): Multiple operators in uncontrolled urban areas and point-to-point freight deliveries across the UK.
- Residual ARC-c or ARC-d: These high-complex environments will require ARC-c approved DAA solutions and mandatory Electronic Conspicuity (EC) across all aircraft.
- Mature DAA and tactical deconfliction via UTM will be essential for integration, as these high-integrity solutions are not yet widely available for routine commercial use.

ROADMAP FOR BVLOS OPERATIONAL SCENARIOS

Operational scenarios as outlined in CAP3182

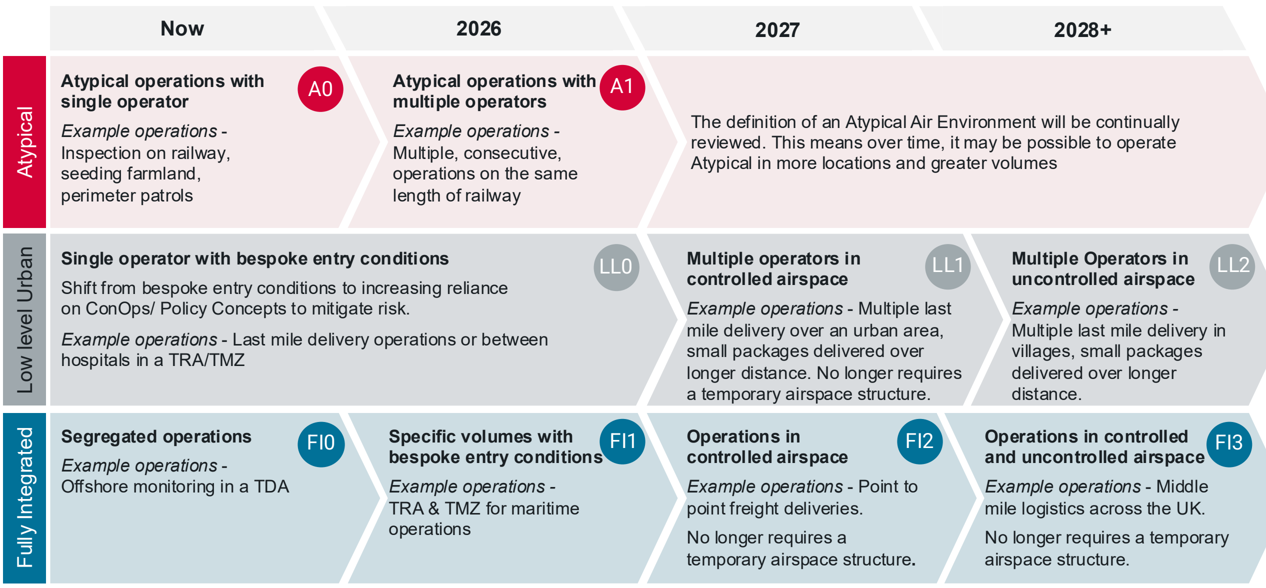

Figure 3. UK CAA Future ATM/ANS ConOps BVLOS Roadmap

Operational Scenarios: Atypical Air Environment

3.18 The UK Civil Aviation Authority's CAP3040 policy[23] concept enables UAS operators to conduct BVLOS operations today by utilising an AAE (A0). By operating in close proximity to fixed infrastructure where the presence of conventionally piloted aircraft is significantly reduced, operators can mitigate mid-air collision risks without the immediate need for complex DAA technologies. This framework provides a clear, actionable path for immediate Operational Authorisation in the "Specific" category.

[23] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

3.19 Currently, CAP3040[23] authorisations are typically granted for a single operator within a specific "volume" of airspace. The roadmap identifies 2026 as the transition year for multi-operator AAE environments.

- Strategic Deconfliction: Instead of relying on a first-come, first-served basis, operators will use UTM systems to coordinate flight paths and schedules.
- Collaborative Safety: Multiple drones (e.g. one inspecting a railway and another a nearby power line) will need to share data to ensure they maintain safe separation while both remain within the "Atypical" volume, according to the OA obtained.

Atypical Airspace Operations with a Single Operator (A0)

Overview and Context

Scenario Description

3.20 Single UAS operator in an environment under CAP3040 Third Edition guidance, applying Annex A smoothing techniques and Annex B principles for structured corridors.[24]

3.21 This first scenario involves BVLOS UAS operations for power line inspection purposes, which can be carried out currently by considering the operational volume as an AAE, following CAP3040 guidelines, so the ARC is set to ARC-a.

[24] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

SCENARIO A0 - REPRESENTATION

UAS BVLOS operation performing power infrastructure inspection

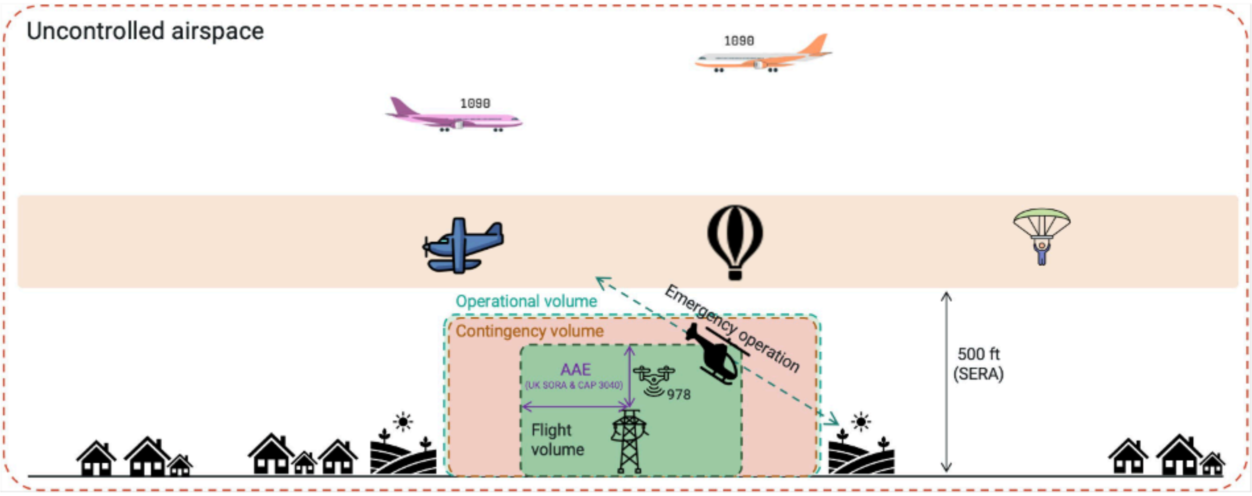

Figure 4. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.22 The geographical location fits a rural environment with Class G airspace (uncontrolled), hence the inclusion of the 500 ft minimum height for manned traffic per SERA.[25]

3.23 The operational volume is considered an AAE, following the CAP3040[26] example for operations above-ground linear infrastructure.

3.24 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-a.

3.25 Applying CAP3040 (Third Edition), there is a need to publish a NOTAM or an AIC as part of the pre-tactical flight route notification. There is also the requirement for equipping EC (ADS-B as required by CAP3040[26] and with equipage as per CAP3140[27]).

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.26 Not applicable for this scenario as today's use case.

3.27 This scenario provides a visual example of how the UK CAA is currently offering a regulatory tool to enhance ARC-a scenarios.

[25] However, it is recognised that aircraft may operate below 500 ft AGL in such environments, and this is considered within the air risk assessment as part of CAP3040

[26] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[27] CAP3140 on Electronic Conspicuity – Initial Technical Concept of Operations (EC ConOps) 2025

Scenario Considerations

3.28 Airspace and Air Traffic Management

- A NOTAM and/or AIC may be issued as part of the pre-tactical flight route notification to ensure other airspace users are aware of the UAS operation and to support situational awareness in the vicinity of the operational corridor.
- Utilisation of the AAE volume mechanism, reducing the probability of encountering manned aircraft that are required by SERA to maintain higher altitudes (500 ft AGL or 1,000 ft AGL)[28] (except for emergency air services / HEMS, or other specific activities).
- Where the operational corridor intersects known ATZ, FRZs, Restricted Areas, etc, or where local traffic patterns indicate potential interaction, coordination with nearby general aviation airfields or strips within a 5 km radius may be established through a flight permission or equivalent local arrangement.

3.29 Altimetry Layers

- The UAS operation is conducted within 50 ft above a permanent linear structure, in this scenario, a power line, but it could also be a railway line, or a road, for example.
- Different altimetric reference systems (GNSS, barometric, radio altimetric, or some combination thereof) can be used to obtain accurate vertical navigation and to ensure vertical positioning with respect to the linear structure.
- Application of Annex A vertical smoothing techniques to account for topographical changes beneath the power lines, ensuring continued proximity to the structure across varying terrain.
- Altitude constraints are defined in the Operational Authorisation (OA) to ensure the operation remains consistent with the characteristics of an AAE.

3.30 Airspace Authorisation and Flight Planning

- An OA is obtained through UK SORA by demonstrating low GRC consistent with a rural environment and by evidencing that the Air Risk Class is assessed as ARC-a based on proximity to infrastructure.
- Flight planning defines the operational volume, lateral and vertical limits, and contingency procedures necessary to maintain AAE conditions throughout the mission.

[28] SERA – Standardised Rules of the Air

3.31 Electronic Conspicuity (EC)

- The UAS is equipped with EC capability (ADS-B) in accordance with CAP3040[29] and CAP3140 specifications, supporting cooperative visibility and situational awareness for other airspace users.
- Additional see-and-avoid mitigations are not required; however, supplementary cooperative systems may be employed to enhance local traffic awareness and improve situational awareness.
- No additional EC equipage requirements are imposed on crewed aircraft beyond those already applicable to the surrounding airspace.
- Where available, the Remote Pilot may monitor traffic information derived from EC or situational awareness tools to support timely decision-making.

3.32 Unmanned Aircraft System Traffic Management (UTM)

- UTM services are not required for A0 operations.
- Under ARC-a in an AAE, the likelihood of encounters with other airspace users is reduced primarily through operational proximity to infrastructure.
- UTM services, if used, are informational only and do not form part of the air risk mitigation strategy.

3.33 Detect and Avoid (DAA)

- No automatic collision avoidance nor traffic or alerting display capabilities are required; Remote Pilots must comply with the requirements set out in UK Regulation (EU) 2019/947 UAS.SPEC.060, in particular UAS.SPEC.060(3)(b).
- If EC alerts indicate an intruder approaching the operational corridor, the Remote Pilot shall execute predefined contingency actions (e.g. landing, loitering, or retreat along the corridor) to maintain safety.
- No credit is claimed for DAA under UK SORA for this scenario. No automatic collision avoidance, but Remote Pilots must comply with requirements set out in UK Regulation (EU) 2019/947 UAS.SPEC.060, in particular UAS.SPEC.060(3)(b).

3.34 Right-of-Way Rules

- In uncontrolled airspace, right-of-way requirements continue to be applied in accordance with UK SERA rules.

[29] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

- If the UAS operator becomes aware that emergency operations are taking place in the vicinity of its operating corridor, regardless of the means of knowledge, UAS operations will be suspended or terminated as necessary.

3.35 Non-Nominal and Contingency

- Contingency in the Operational Volume is addressed by UK SORA and would be part of the process of the OA application.
- C2 Link Failure: A predefined lost-link procedure is executed, designed to keep the UA within the linear operational volume.
- GNSS Degradation: Where available and validated, inertial navigation or visual odometry is used to maintain position relative to the power line, preventing excursion into non-atypical airspace.
- Unexpected Airspace Activity: The Remote Pilot may interrupt or terminate the operation if conditions no longer support the assumptions underpinning the AAE.

SCENARIO A0 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario A0

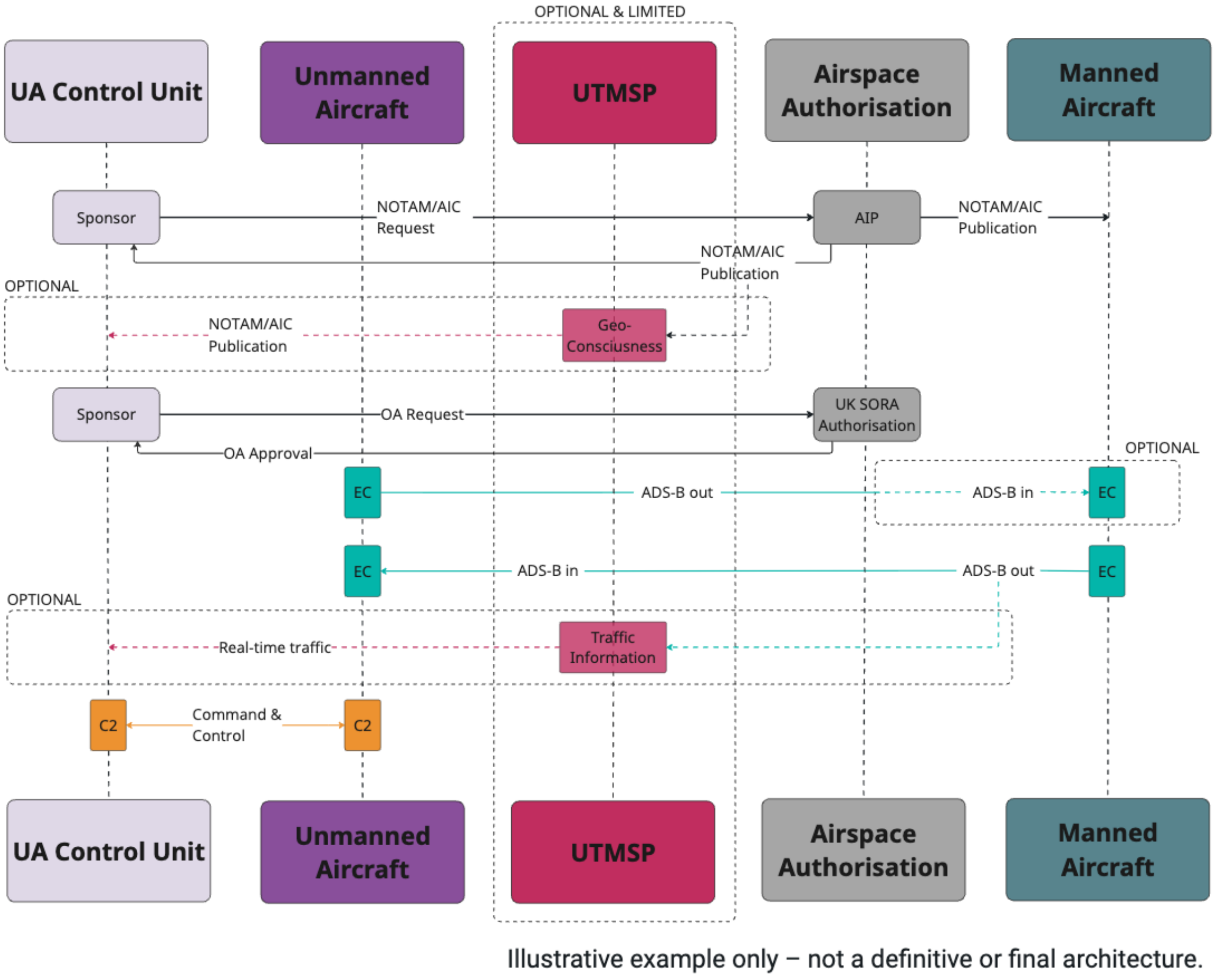

Figure 5. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.36 For A0 AAE operations, the following system capabilities are mandatory to support safe BVLOS operations in low air risk environments, consistent with CAP3040[30] and the A0 operational pathway described in the BVLOS Roadmap.

- Electronic Conspicuity (EC)

[30] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

- Unmanned aircraft shall be equipped with ADS-B Out and ADS-B In capability. Transmitting on 978 MHz and receiving on dual frequencies 978 MHz and 1090 MHz, in accordance with CAP3040 and EC equipage specifications, to support cooperative detect-and-avoid awareness and airspace visibility.

- Command and Control (C2) Link
  - A reliable and secure C2 Link approved for SAIL 1 to SAIL 3 operations shall be provided, ensuring continuous command, control, and contingency management throughout the BVLOS operation.
- Navigation and Containment
  - GNSS-based navigation with geofencing and terrain-aware flight capability shall be implemented to ensure operations remain within the defined AAE operational volume and in close proximity to the relevant fixed infrastructure.
- Operational Compliance
  - The Remote Pilot shall comply with the collision-avoidance and right-of-way obligations set out in UK Regulation (EU) 2019/947 (UAS.SPEC.060), including interruption or termination of the flight if continuation could pose a risk to other airspace users.

Optional System Capabilities

3.37 The following system capabilities are not required for A0 operations but may be deployed to enhance situational awareness, resilience, or operational robustness without altering the applicable ARC.

- Additional Cooperative Surveillance Technologies
  - Voluntary carriage of supplementary cooperative surveillance systems to enhance local traffic awareness beyond the minimum EC requirements.
- Ground-Based Traffic Awareness
  - Use of local ground receivers or situational awareness displays to supplement airborne EC data, where available, based on GI.
- UTM Services (Informational Only)
  - UTM services are not required for A0 operations; however, operators may optionally use UTM platforms for flight planning or information display purposes, noting that UA-to-UA coordination does not constitute an air risk mitigation under UK SORA.
- Enhanced C2 Resilience

- Secondary or alternative C2 communication paths (e.g. multi-bearer cellular links) to improve operational robustness, where proportionate to the operation.

Scenario Technical Architecture

SCENARIO A0 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario A0

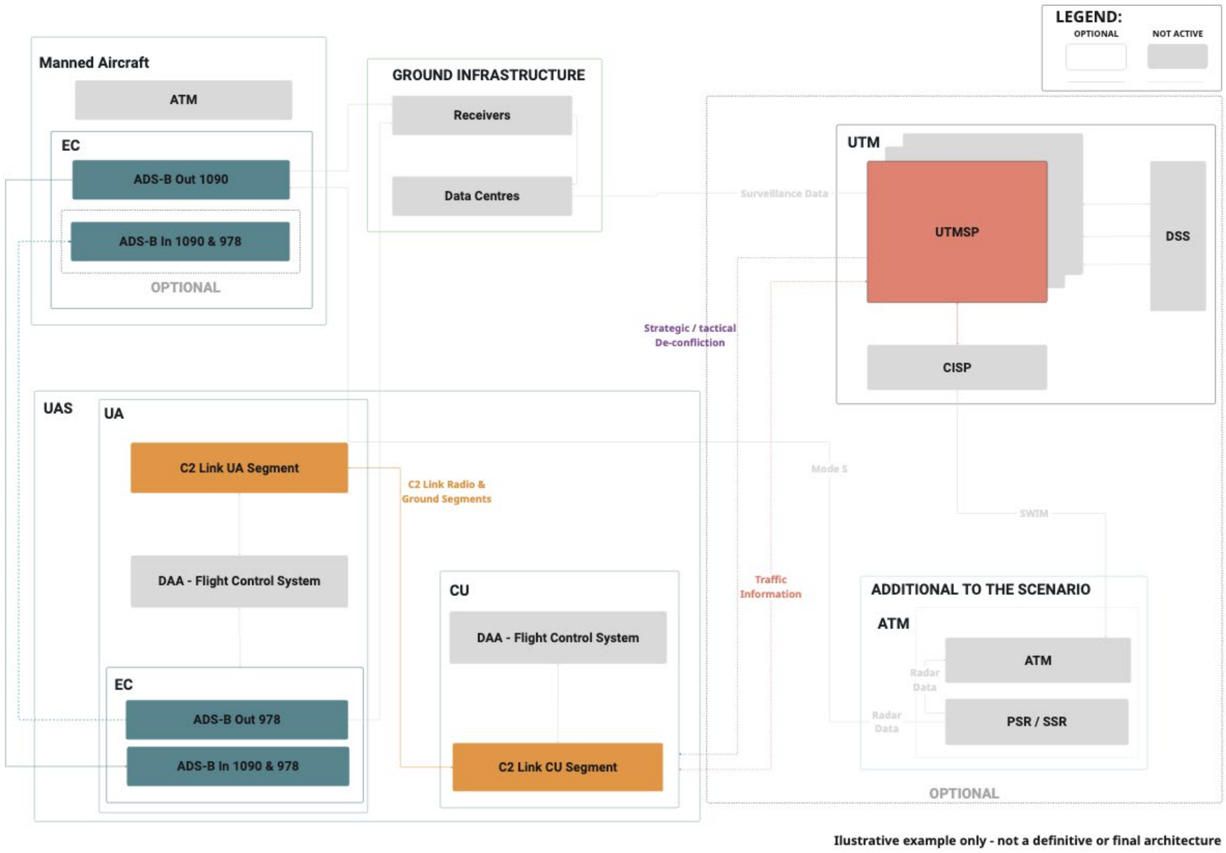

Figure 6. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Atypical Airspace Operations with Multiple UAS Operators (A1)

Overview and Context

Scenario Description

3.38 Concurrent AAE operations conducted by multiple operators along the same length of railway, for example, with one operator performing track inspection and another providing security or trespass monitoring, regardless of the number of UAS deployed by each operator.

3.39 Multiple BVLOS operations in an urban (populated areas) Class D (controlled) environment are enabled under CAP3040[31] Third Edition guidance, applying Annex A smoothing techniques and Annex B principles for structured corridors.

3.40 All UAs are equipped with ADS-B equipment. The activity is coordinated with the ANSP, or a UTMSP if available, depending on UA traffic density, supporting safe and scalable operations by multiple operators in the same urban area.

SCENARIO A1 - REPRESENTATION

UAS BVLOS operation of multiple operators in the same area with one operator doing track inspection and one operator providing security/trespass overwatch.

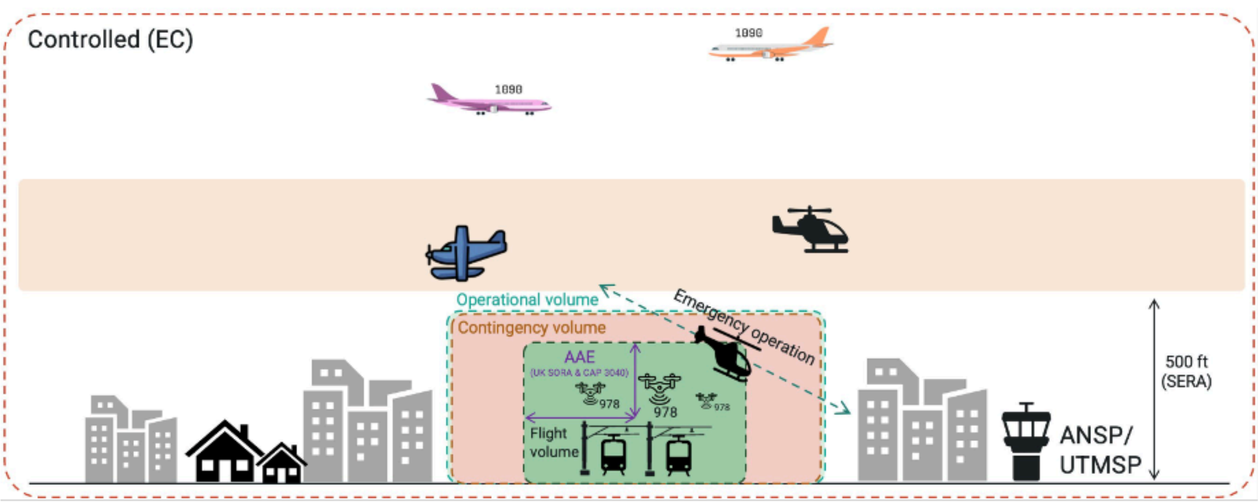

Figure 7. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.41 Airspace Class: Class D (controlled) – Urban location

3.42 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-a.

[31] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

3.43 Operation following CAP 3040[32] guidance, including Annex A (smoothing) and Annex B (base reference for railway infrastructure).

3.44 BVLOS operations are possible by complying with EC requirements for UAS Operators as described in CAP3040[33] and with equipage as per CAP3140.[34]

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.45 The operational description fits under AAE, and the initial ARC is ARC-a.

3.46 The use of strategic mitigations is in place:

- Progress towards 2028: Use of SUA is not considered.
- “Pre-agreement of any ANSP services to be used in-flight” and confirming maximum altitude by “Operational restriction by boundary”.
- Based on ANSP coordination, NOTAM, or AIC, of intended operation will be required.

3.47 The use of tactical mitigations is in place

- Carriage of EC out.
- Monitoring of local traffic.

3.48 Optional mitigations to the scenario to enhance scalability under the UK SORA framework:

- Pre-agreement of any UTM services to be used in-flight.

Scenario Considerations

3.49 Airspace and Air Traffic Management

- Pre-tactical coordination with ANSP ensures separation between UAS and manned routes.
- A NOTAM, or AIC, is issued as part of the pre-tactical flight route notification to ensure other airspace users are aware of the UAS operation.
- Defined minimum lateral and vertical separation distances between the two concurrent operators, depending on their system (fixed wing/multirotor/VTOL) to prevent "near-miss" events between the inspection and security UAS.

[32] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[33] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[34] CAP3140 on Electronic Conspicuity – Initial Technical Concept of Operations (EC ConOps) 2025

3.50 Altimetry Layers

- In accordance with CAP3040, the UAS operation is taking place within 50 ft of a permanent linear structure, for example, a railway, road, or powerline. If this linear structure is flanked by buildings or other substantial man-made structures running parallel to the track, these features may be considered as the reference structure of the AAE above linear infrastructure, provided they present a consistent and substantial linear obstacle within the proposed operational area.

3.51 Airspace Authorisation and Flight Planning

- OA through UK SORA is obtained by demonstrating that the ground risk (GRC) is low and the Air Risk Class is fixed at ARC-a.
- Operators submit intended flight paths as part of pre-flight planning.
- Where available, UTM services support airspace authorisation by enabling strategic deconfliction and validation of flight paths between concurrent operators prior to launch.
- Where UTM services are not available, operators coordinate directly to ensure separation of operational volumes, with flight execution contingent upon confirmation of the agreed flight paths and maintenance of AAE conditions.

3.52 Electronic Conspicuity (EC)

- The UAS is equipped with EC (ADS-B as required by CAP3040[35] specifications and with equipage as per CAP3140[36]).
- EC supports cooperative awareness between UAS and other airspace users; no additional equipage is imposed on crewed aircraft beyond airspace requirements.
- Supplementary cooperative surveillance systems, including the use of Ground Infrastructure, may be used to enhance local awareness.

3.53 Unmanned Aircraft System Traffic Management (UTM)

- UTM services are used depending on UA traffic density, with the RP monitoring local traffic to initiate avoidance manoeuvres.

[35] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

[36] CAP3140 on Electronic Conspicuity – Initial Technical Concept of Operations (EC ConOps) 2025

- Integration with UTM services (if available, depending on UA traffic density) to support pre-flight strategic deconfliction, including the submission, coordination, and approval of flight paths prior to launch. Where UTM services are not available, operators will coordinate directly to ensure separation of their respective operational volumes.

3.54 Detect and Avoid (DAA)

- No automatic collision avoidance, but RPs must comply with requirements set out in UK Regulation (EU) 2019/947 UAS.SPEC.060, in particular UAS.SPEC.060(3)(b).

3.55 Right-of-Way Rules

- Management of operational prioritisation, including emergency situations, is addressed through established operational procedures and coordination mechanisms. Right-of-way requirements continue to be applied in accordance with UK SERA rules.
- Should emergency air operations occur in the vicinity of the corridor, UAS operations will be paused or terminated as necessary.

3.56 Non-Nominal and Contingency

- Contingency in the Operational Volume is addressed by UK SORA and would be part of the process of the OA application.
- C2 Link Failure: The UAS will execute an automated Return to Home following the "Corridor Smoothing" path (Annex A) to ensure it stays within the protected linear volume during transit.
- GNSS Degradation: Where available and validated, inertial navigation or visual odometry is used to maintain position relative to the power line, preventing excursion into non-atypical airspace.
- Containment Breach: Immediate notification procedure to the ANSP (local ATC) if the UAS exits the volume boundaries (fly-away scenario).
- Unexpected Airspace Activity: The Remote Pilot may interrupt or terminate the operation if conditions no longer support the assumptions underpinning the AAE.

SCENARIO A1 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario A1

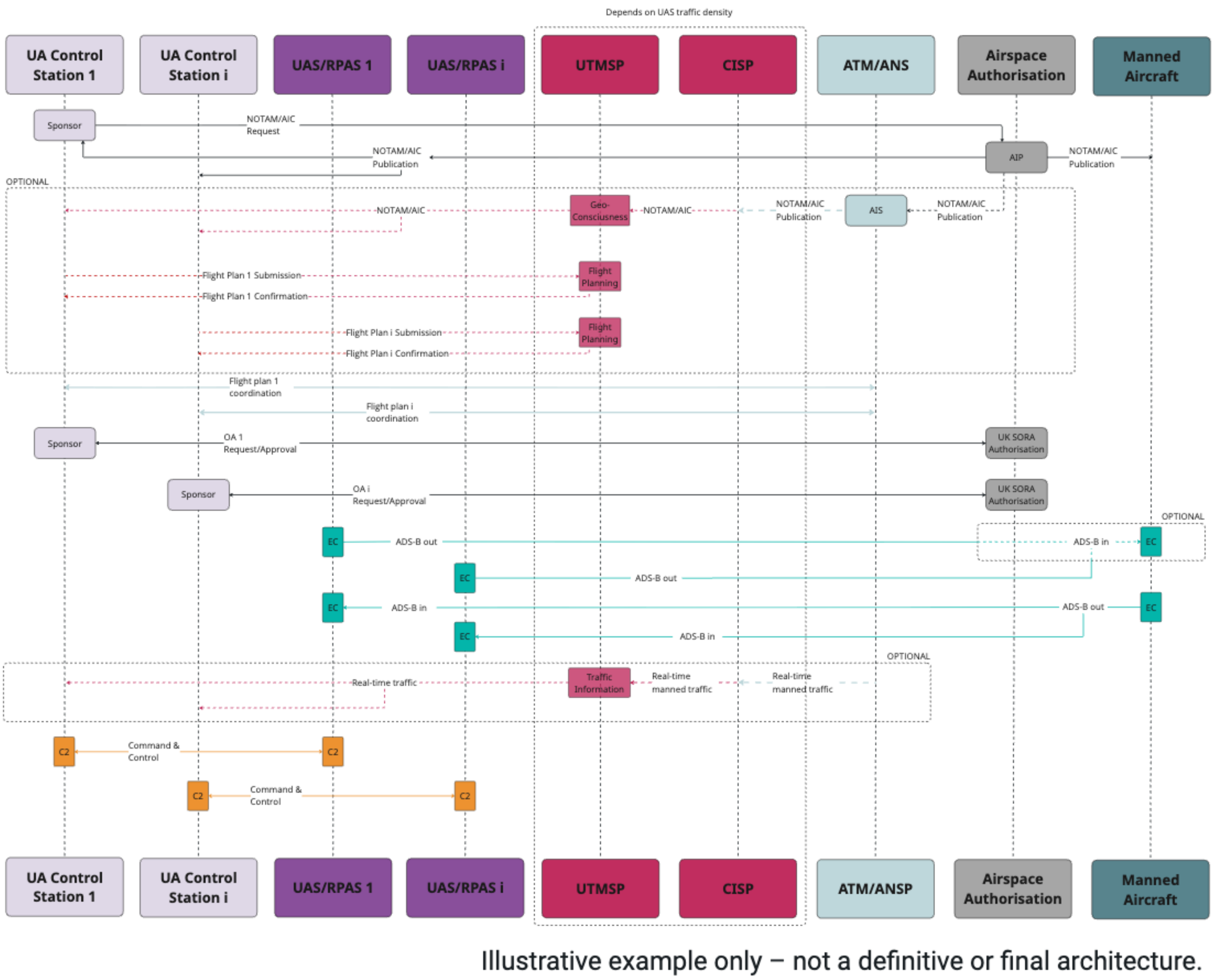

Figure 8. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.57 For A1 Atypical Air Environment operations[37] involving multiple concurrent operators within the same operational volume, the following system capabilities are mandatory to enable safe and scalable BVLOS operations while maintaining the characteristics of an AAE:

- Electronic Conspicuity (EC)

[37] CAP3040 (Third Edition) on Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

    - All unmanned aircraft shall be equipped with ADS-B Out and ADS-B In capability transmitting on 978 MHz and receiving on dual frequencies on 978 MHz and 1090 MHz. This is in accordance with CAP3040 and applicable EC equipage specifications, to ensure cooperative visibility between UAS and other airspace users.
- Command and Control (C2) Link
    - A secure and reliable C2 Link approved for SAIL 1 to SAIL 3 operations shall be provided for each UAS, ensuring continuous command, control, and contingency management during BVLOS flight.
- Navigation and Containment
    - GNSS-based navigation with geofencing and terrain-aware flight capability shall be implemented to ensure that all operations remain within the defined AAE operational volume and in close proximity to the relevant fixed infrastructure.
- Pre-Flight Strategic Coordination
    - Operators shall coordinate intended flight paths prior to launch to ensure separation of operational volumes. Where available, this coordination shall be supported by UTM services as part of pre-flight checks and approval of flight paths.
- Operational Compliance
    - Remote Pilots shall comply with the collision-avoidance and right-of-way obligations set out in UK Regulation (EU) 2019/947 (UAS.SPEC.060), including interruption or termination of flight where continuation could pose a risk to other airspace users.

Optional System Capabilities

3.58 The following system capabilities are not mandatory for A1 operations but may be employed to enhance scalability, coordination efficiency, and situational awareness as UA traffic density increases:

- UTM Services (Strategic Deconfliction)
  Use of established UTM services to support pre-flight airspace authorisation, strategic deconfliction, and coordination of flight paths between multiple operators. The use of UTM services is dependent on UA traffic density and does not alter the applicable ARC, in line with UK SORA principles.
- Additional Cooperative Surveillance Technologies
  Voluntary carriage of supplementary cooperative surveillance systems (e.g. FLARM, PilotAware) to enhance local traffic awareness beyond the minimum EC requirements.

- Ground-Based Traffic Awareness
  Use of ground receivers, situational awareness displays, or data aggregation services to supplement airborne EC data and support monitoring of local cooperative traffic, as part of the GI.
- Enhanced C2 Resilience
  Secondary or alternative C2 communication paths (e.g. multi-operator cellular or satellite links) to improve resilience and availability.

Scenario Technical Architecture

SCENARIO A1 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario A1

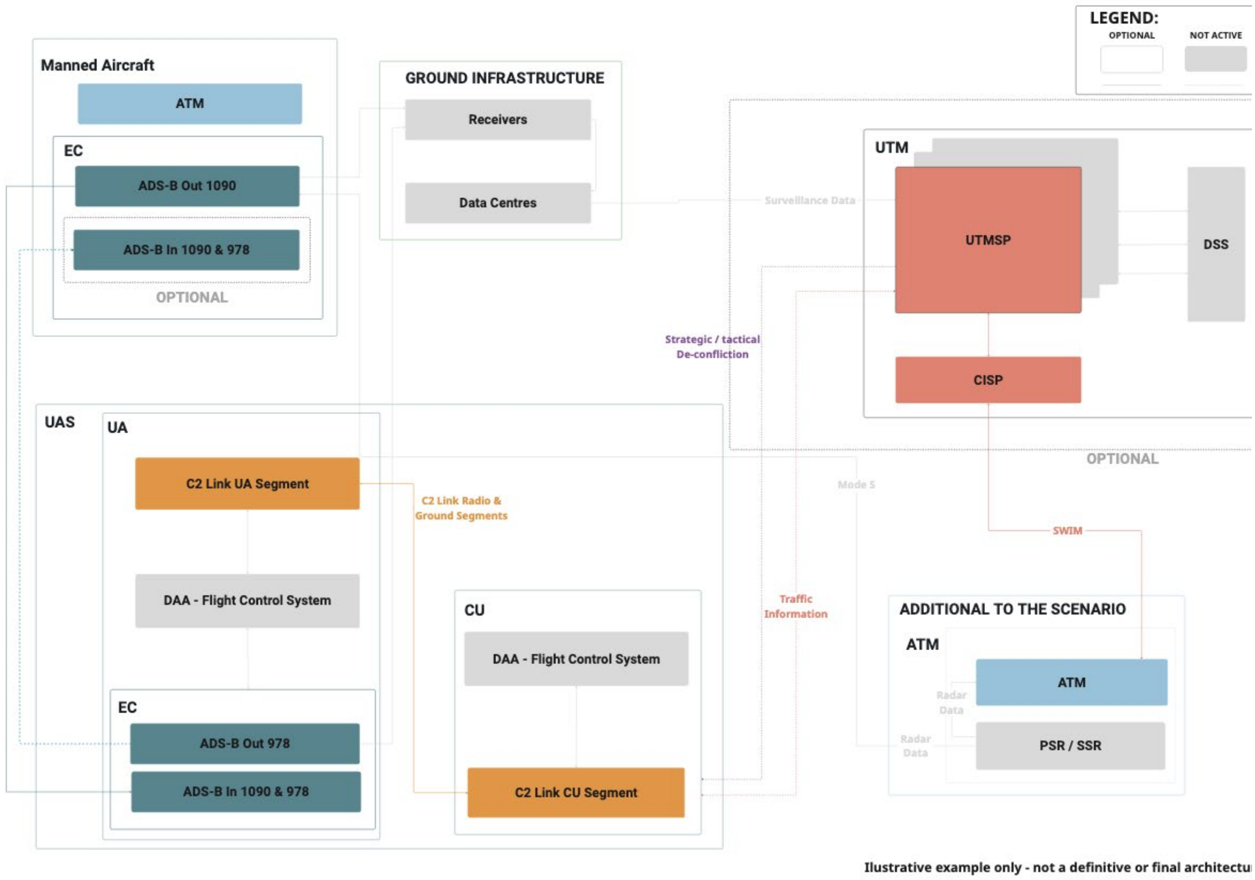

Figure 9. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Operational Scenarios: Low-Level Urban

3.59 Today, low-level urban BVLOS operations in the UK are primarily conducted using TRA/TDA and/or TMZ (LL0). These airspace structures serve as essential stepping stones, allowing the industry to generate safety data and test new technologies.

3.60 However, this current model faces significant challenges regarding scalability:

- Airspace Change Process (CAP1616): Establishing these temporary volumes requires an ACP. This process is often time-consuming, with typical applications taken approximately 8 to 12 months for complex TRA/TDA. Even if reduced significantly, the requirement to use a case-by-case process to establish bespoke activity introduces repeated regulatory decision points and reduces planning certainty for operators.
- Limited Flexibility: These structures are often "bespoke" and tied to specific, short-duration missions. The rigid nature of current segregation means it is not yet possible to support multiple concurrent operators or widespread urban logistics without significant administrative overhead.
- Resource Intensity: Each operation requires an individual OA as per UK SORA and intense coordination with ANSPs, which limits the ability of the sector to move from "trials" to routine commercial services.

Single Operator with Bespoke Entry Condition (LL0)

Overview and Context

Scenario Description

3.61 This scenario describes a single-operator BVLOS operation conducted at low level in an urban area of Class G (uncontrolled) airspace up to 1000 ft AGL. This is supported by a dedicated TRA/TDA that ensures predictable access and reduces encounter likelihood with other airspace users. An example of this could be a ground surveillance operation.

3.62 Both unmanned and manned aircraft use ADS-B-based entry conditions as per a TMZ, creating a cooperative environment where traffic can be effectively managed. The nearby ANSP provides oversight and TRA/TDA access coordination, ensuring the operation remains safe and scalable.

SCENARIO LL0 - REPRESENTATION

UAS BVLOS operation performing ground surveillance operation in Class G airspace

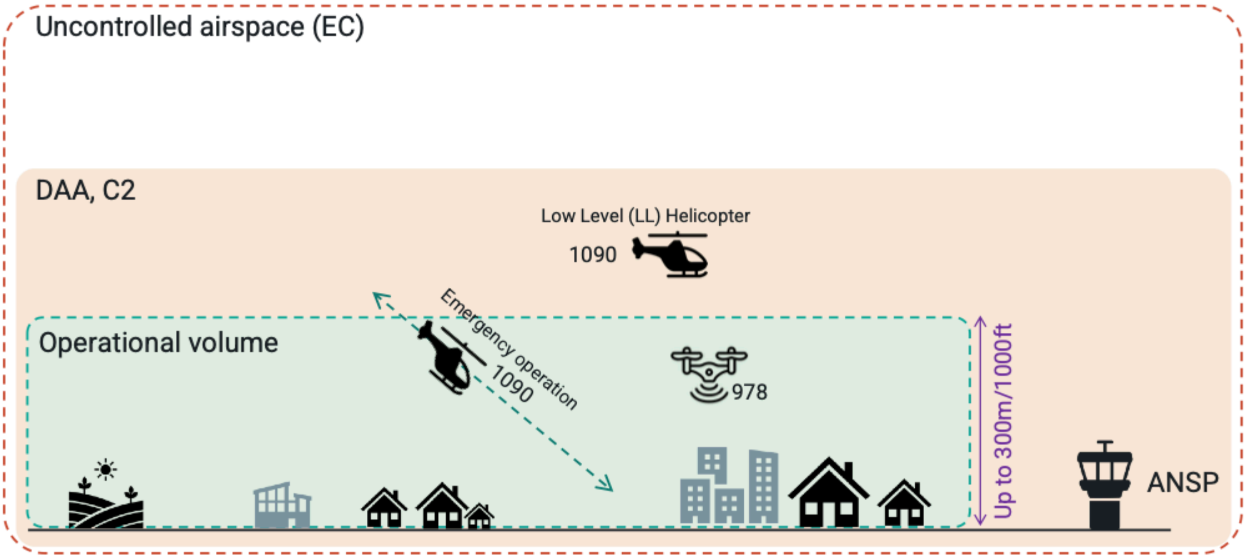

Figure 10. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.63 Airspace Class: Class G (uncontrolled).

3.64 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-c.

3.65 BVLOS operations are only possible by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.66 The operational description implies the initial ARC is ARC-c, and by use of strategic mitigations, it is reduced to residual ARC-a.

3.67 The use of strategic mitigations is in place:

- SUA, defining Temporary Restricted Area (TRA) or Temporary Danger Area (TDA). It can also be permanent.
- Other airspace requirements, defining a TMZ.[38]
- Based on ANSP coordination:

[38] UK SORA Annex C 1.14. “in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment”.

- The nearby ANSP provides oversight and TRA/TDA access coordination, ensuring the operation remains safe and scalable.[39] Noting the ANSP may only provide TRA/TDA coordination services for controlled airspace, further consideration is required for appropriate procedures in uncontrolled airspace.

3.68 The use of tactical mitigations is in place:

- Carriage of EC out.[40]
- Monitoring of local traffic.

3.69 Optional mitigations to enhance scalability under the UK SORA framework:

- Pre-agreement of any UTM services to be used in-flight.

Scenario Considerations

3.70 Airspace and Air Traffic Management:

- SUA which can also be permanent, are managed by the nearby ANSP. Noting the ANSP may only provide coordination services for controlled airspace, further consideration is required for appropriate procedures in uncontrolled airspace.
- Implementation of lateral and vertical "safety buffers" around the operational volume and up to the TRA/TDA boundaries to account for navigation performance and prevent unintended excursions into active Class G airspace.
- Coordination with the ANSP supports MAC mitigation and prioritisation of crewed traffic.
- ANSP procedures are specific to the trial or operation.

3.71 Altimetry Layers

- UAS always operate below 1000 ft AGL.
- Definition of a "safety" buffer layer if manned traffic is expected to transit the TMZ at specific heights, ensuring vertical separation is maintained even during pressure changes.

[39] Crewed TRA/TDA entry conditions, as 1 - carriage and operation of ADS-B Out as described in CAP3140; and 2 - pre-notification of access (Written/email days in advance, telephone call hours in advance, VHF radio call minutes in advance).

[40] In line with the specifications described in CAP3140.

3.72 Airspace Authorisation and Flight Planning

- TRA/TDA access managed by ANSP, granting access to airspace users based on written/email days in advance, telephone call hours in advance, and VHF radio call minutes in advance. The ANSP will coordinate with the UAS operator to pause or end UAS operations if manned traffic requires entry into the TRA/TDA. Noting the ANSP may only provide TRA/TDA coordination services for controlled airspace, further consideration is required for appropriate procedures in uncontrolled airspace.

3.73 Electronic Conspicuity (EC)

- TMZ mandates the equipage for manned and unmanned aircraft with EC devices in line with the specifications described in CAP3140. If manned traffic is detected by the UAS operator, the operation will be paused or ended until the manned traffic exits.

3.74 Unmanned Aircraft System Traffic Management (UTM)

- UTM services are utilised based on UA traffic density; they are likely optional or not required in this scenario.
- Integration with the UTM service (if utilised), depending on UA traffic density. At a minimum, operators will coordinate to separate their operational volumes.

3.75 Detect and Avoid (DAA)

- DAA is not approved, and it is only in place for testing purposes.

3.76 Right-of-Way Rules

- Management of operational prioritisation, including emergency situations, is addressed through established operational procedures and coordination mechanisms, while right-of-way requirements continue to be applied in accordance with UK SERA rules.
- Should emergency air operations occur in the vicinity of the operational volume, UAS operations will be paused or terminated as necessary.

3.77 Non-Nominal and Contingency

- Loss of EC: Protocol for the UAS to land or return to base immediately if its own ADS-B/EC device fails during flight.
- Weather Minima: Specific triggers for mission suspension (e.g. wind gusts exceeding UA limits or cloud base dropping below 1000 ft AGL), as rural surveillance is highly sensitive to environmental changes.
- Contingencies are managed via ANSP-agreed procedures and predefined safe locations.

SCENARIO LL0 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario LL0

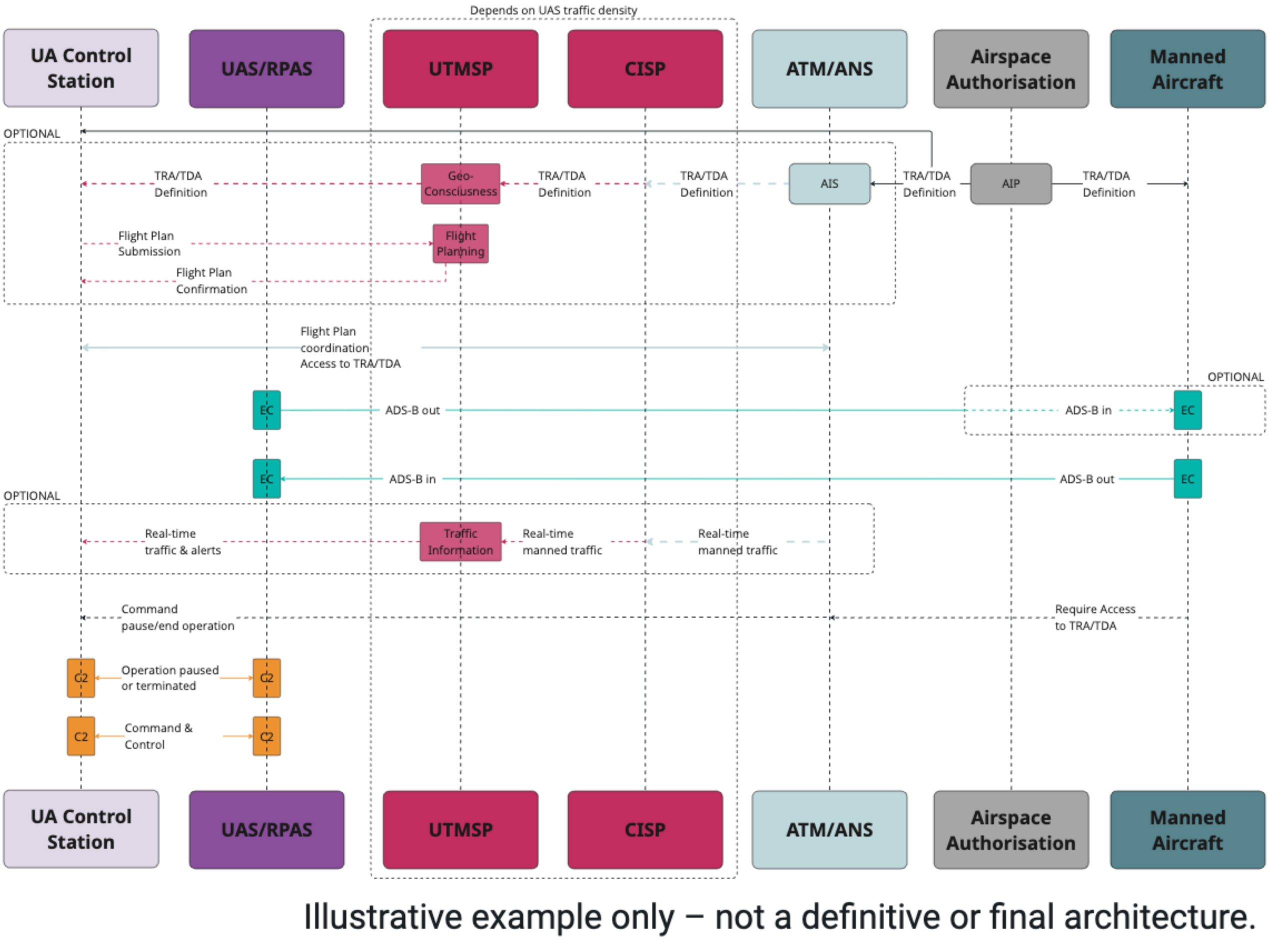

Figure 11. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.78 Electronic Conspicuity (EC)

- Unmanned aircraft shall be equipped with ADS-B Out (978 MHz) and ADS-B In (978/1090 MHz) in accordance with CAP3140 and applicable TMZ requirements. Crewed aircraft operating within the defined volume shall comply with EC equipage requirements prescribed for the airspace.

3.79 Command and Control (C2) Link

- A secure and reliable C2 Link approved for the applicable SAIL shall be provided.

3.80 Special Use Airspace (SUA)

- Operations shall be conducted within a TRA/TDA and/or TMZ established as a strategic mitigation to reduce the initial ARC to an acceptable residual level.

3.81 Navigation and Containment

- GNSS-based navigation, geofencing, and obstacle-aware flight capability shall be implemented to ensure containment within the authorised low-level volume.

Optional System Capabilities

3.82 UTM Services (Strategic Support)

- Optional use of UTM services for flight planning and coordination, dependent on UA traffic density.

3.83 Enhanced Surveillance Infrastructure

- Use of ground receivers or situational awareness displays to supplement EC data.

Scenario Technical Architecture

SCENARIO LL0 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario LL0

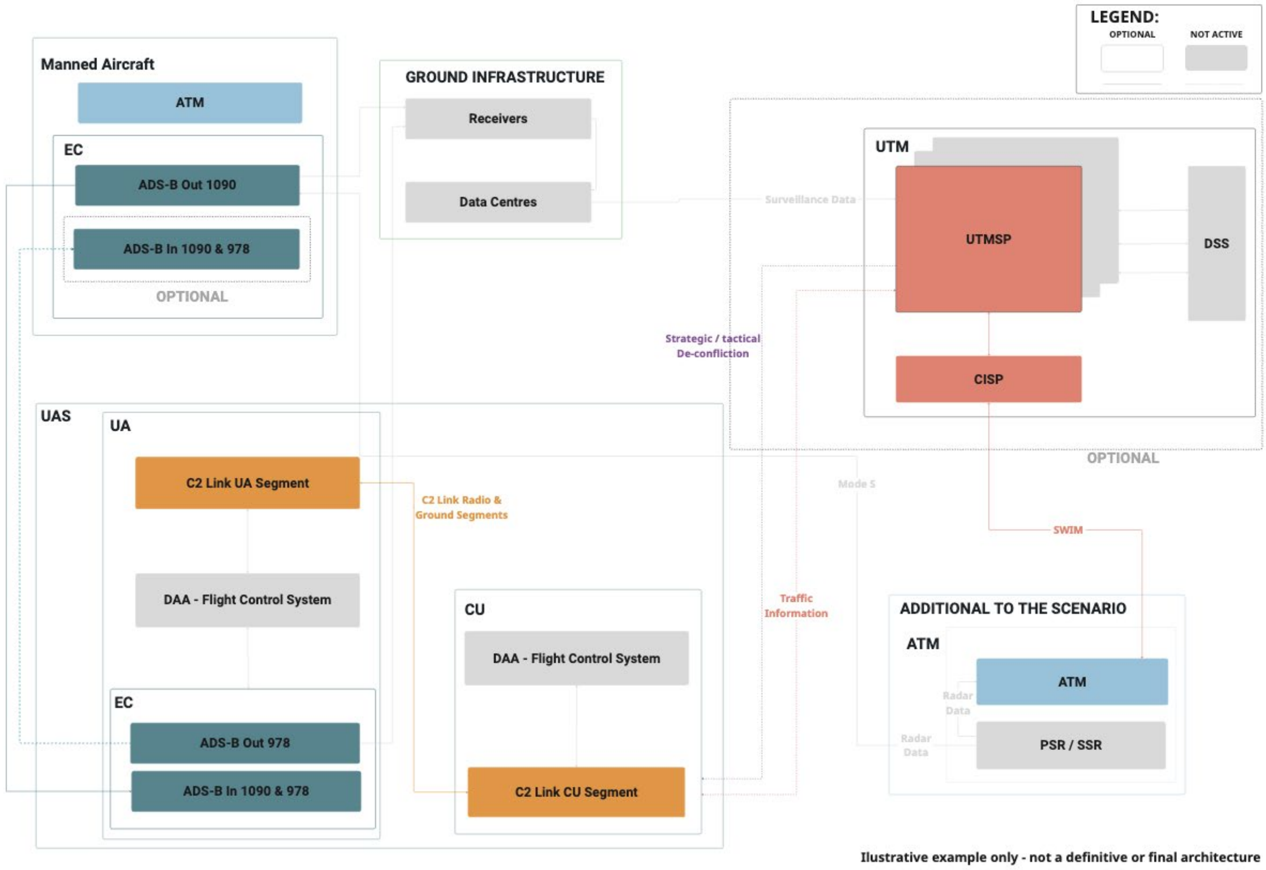

Figure 12. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Multiple UAS Operators in Controlled Airspace (LL1)

Overview and Context

Scenario Description

3.84 This scenario describes multiple UAS BVLOS operators conducting flights at low level within an urban Class D (controlled) environment, up to 500 ft AGL, where both demand and airspace complexity are higher. An example of such an operation would be delivery operations for the NHS.

3.85 Without the use of temporary airspace structures, the activity relies on cooperative surveillance, ADS-B-based visibility, and coordination with the ANSP and/or UTMSP, depending on traffic density. This creates a predictable, scalable operating environment where multiple operators can safely conduct routine delivery missions across a busy urban area.

SCENARIO LL1 - REPRESENTATION

UAS BVLOS delivery operation with multiple UAS operators in Class D airspace

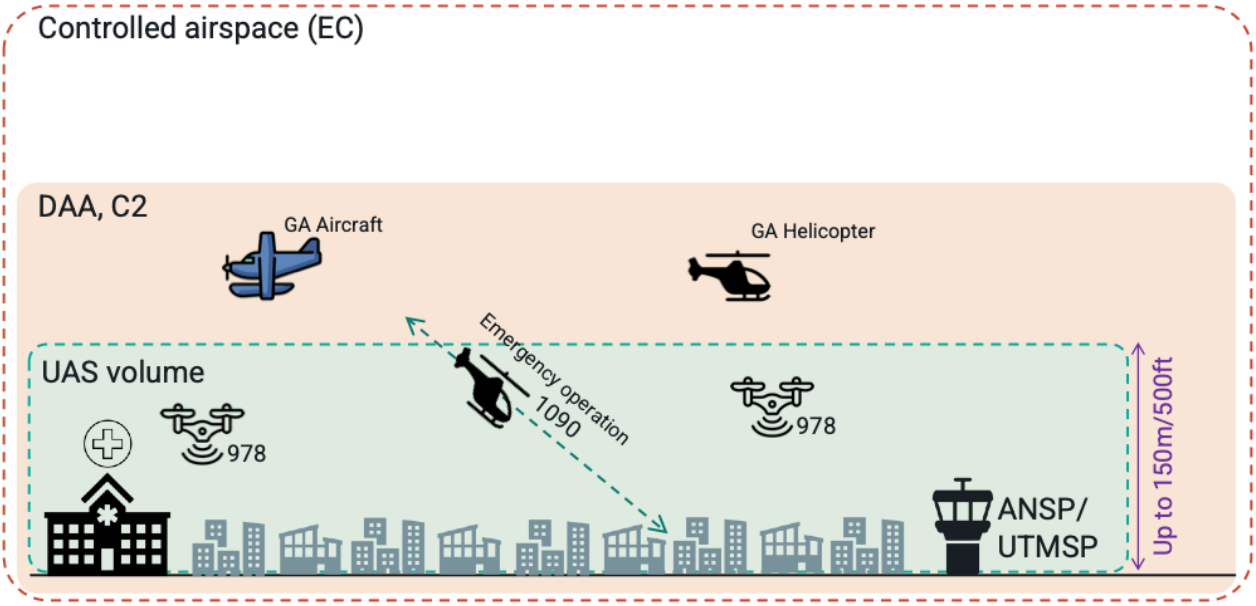

Figure 13. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.86 Airspace Class: Class D (controlled).

3.87 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-b.

3.88 BVLOS operations are only possible by complying with DAA requirements for ARC-b or by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.89 The operational description implies the initial ARC is ARC-b, and no temporary airspace structure is used; the residual ARC remains ARC-b.

3.90 The use of strategic mitigations is in place:

- Progress toward 2028: no use of Temporary SUA.
- Other airspace requirements, defining a TMZ.[41]
- Pre-agreement of any ANSP services to be used in-flight, and/or
- Pre-agreement of any UTM services to be used in-flight.

[41] UK SORA Annex C 1.14 ”…in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment”.

- Activity coordinated with ANSP and/or UTMSP based on UA traffic density.

3.91 The use of tactical mitigations is in place:

- DAA capability[42]
- Carriage of EC out
- Monitoring of local traffic

Scenario Considerations

3.92 Airspace and Air Traffic Management

- Pre-tactical coordination with ANSP ensures separation between UAS and manned routes.
- If requested, the NOTAM ensures that other users are aware of the UAS operation.
- Operations occur without temporary airspace structures (SUA), relying on standardised procedures.
- Coordination with ATC is routine and predictable.

3.93 Altimetry Layers

- UAS operates up to 500 ft AGL, inside a specific area.
- Manned aircraft generally operate above 500 ft AGL, except during take-off, landing, emergency operations and other specified activities, military aviation may not conform to this assumption.

3.94 Airspace Authorisation and Flight Planning

- Flight authorisation is supported by UTM and coordinated with ATM.
- Strategic deconfliction is applied across operators.

3.95 Electronic Conspicuity (EC)

- UAS must broadcast and receive ADS-B In & Out signals.
- Manned aircraft must broadcast an ADS-B Out signal.
- Manned aircraft could include optional ADS-B In receivers, having the possibility of receiving ADS-B Out signals from other traffic, improving their situational awareness.

[42] Information Only Display (ground based) DAA as per DAA policy concept (cooperative traffic only), in line with residual ARC

- EC mandate supports routine mixed-traffic operations.

3.96 Unmanned Aircraft System Traffic Management (UTM)

- UTM provides flight authorisation and strategic deconfliction.
- Increasing use of tactical services as traffic density grows.

3.97 Detect and Avoid (DAA)

- DAA is provided through an Information-Only Display system compliant with ARC-b TMPRs. The system provides traffic advisories and alerts to the Remote Pilot, who remains responsible for assessing encounter geometry and executing appropriate avoidance manoeuvres in accordance with approved operating procedures.
- UAS avoidance manoeuvres prioritised per DAA policy & guidance standards.

3.98 Right-of-Way Rules

- Management of operational prioritisation, including emergency situations, is addressed through established operational procedures and coordination mechanisms, while right-of-way requirements continue to be applied in accordance with UK SERA rules.
- Should emergency air operations occur in the vicinity of the operational volume, UAS operations will be paused or terminated as necessary.
- Emergency air traffic is prioritised via standard ATC procedures.
- UAS respond automatically or procedurally as required.

3.99 Non-Nominal and Contingency

- Contingencies are managed through UTM/ATM coordination and DAA-supported responses.
- Loss of system performance may result in rerouting or termination.

SCENARIO LL1 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario LL1

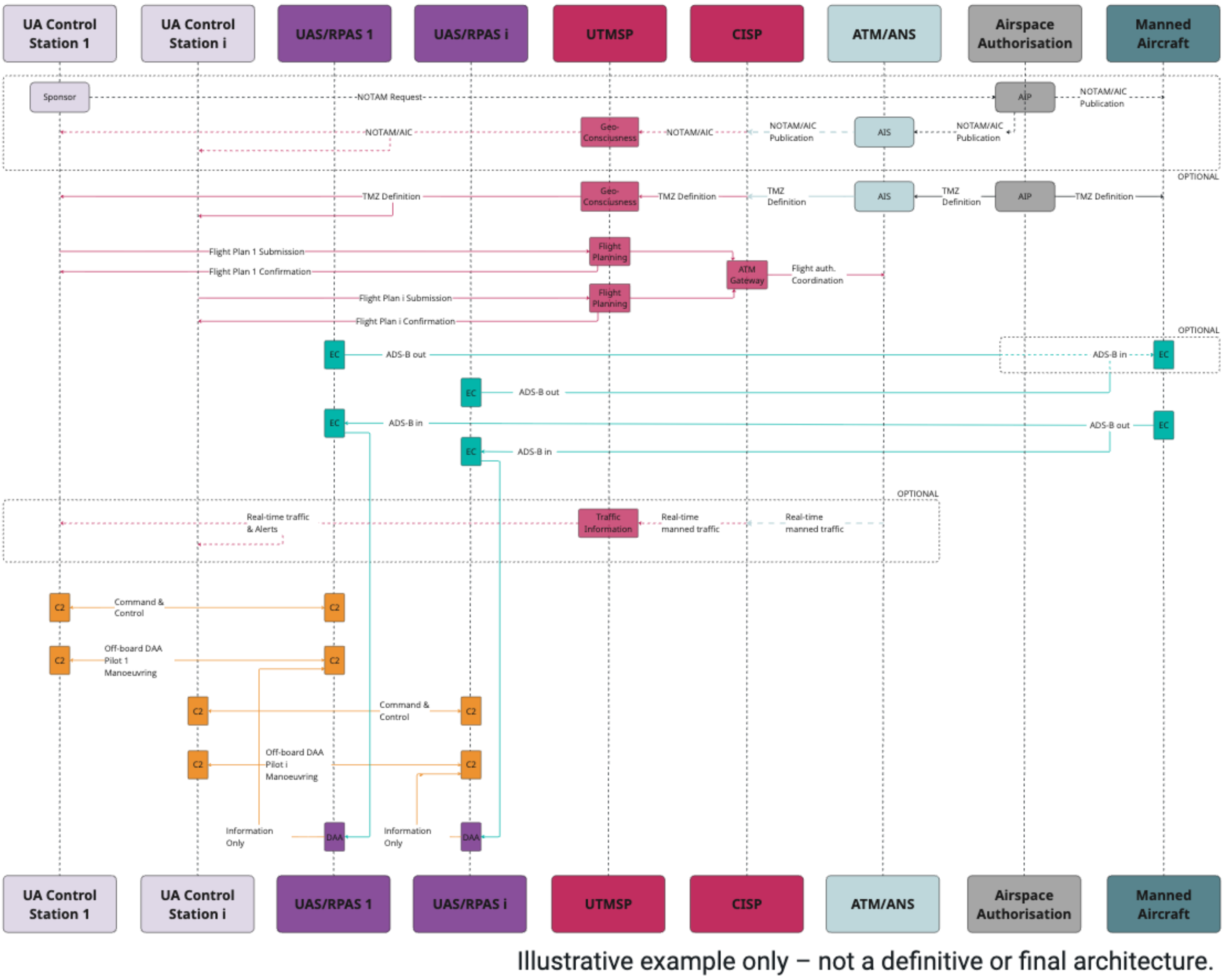

Figure 14. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.100 Electronic Conspicuity (EC)

- All unmanned aircraft shall be equipped with ADS-B Out (978 MHz) and ADS-B In (978/1090 MHz). Crewed aircraft shall comply with EC equipage requirements mandated for the airspace.

3.101 Detect and Avoid (DAA)

- DAA capabilities approved for residual ARC-b shall be implemented to support tactical mitigation in a mixed-traffic environment.

3.102 Command and Control (C2) Link

- Secure, resilient C2 Link approved for higher SAIL shall be provided to support routine multi-operator BVLOS operations.

3.103 Strategic Coordination via ANSP and/or UTMSP

- Pre-flight coordination with the ANSP and/or UTMSP shall be conducted to support flight authorisation, trajectory planning, and strategic deconfliction.

3.104 Navigation and Containment

- Defined altitude layers, geofencing, and obstacle-aware navigation shall be implemented to support predictable low-level operations.

Optional System Capabilities

3.105 UTM Tactical Services

- Use of UTM tactical deconfliction and compliance monitoring services as traffic density increases.

3.106 Ground Infrastructure

- Supporting surveillance infrastructure (e.g. TIS-B, situational awareness displays).

Scenario Technical Architecture

SCENARIO LL1 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario LL1

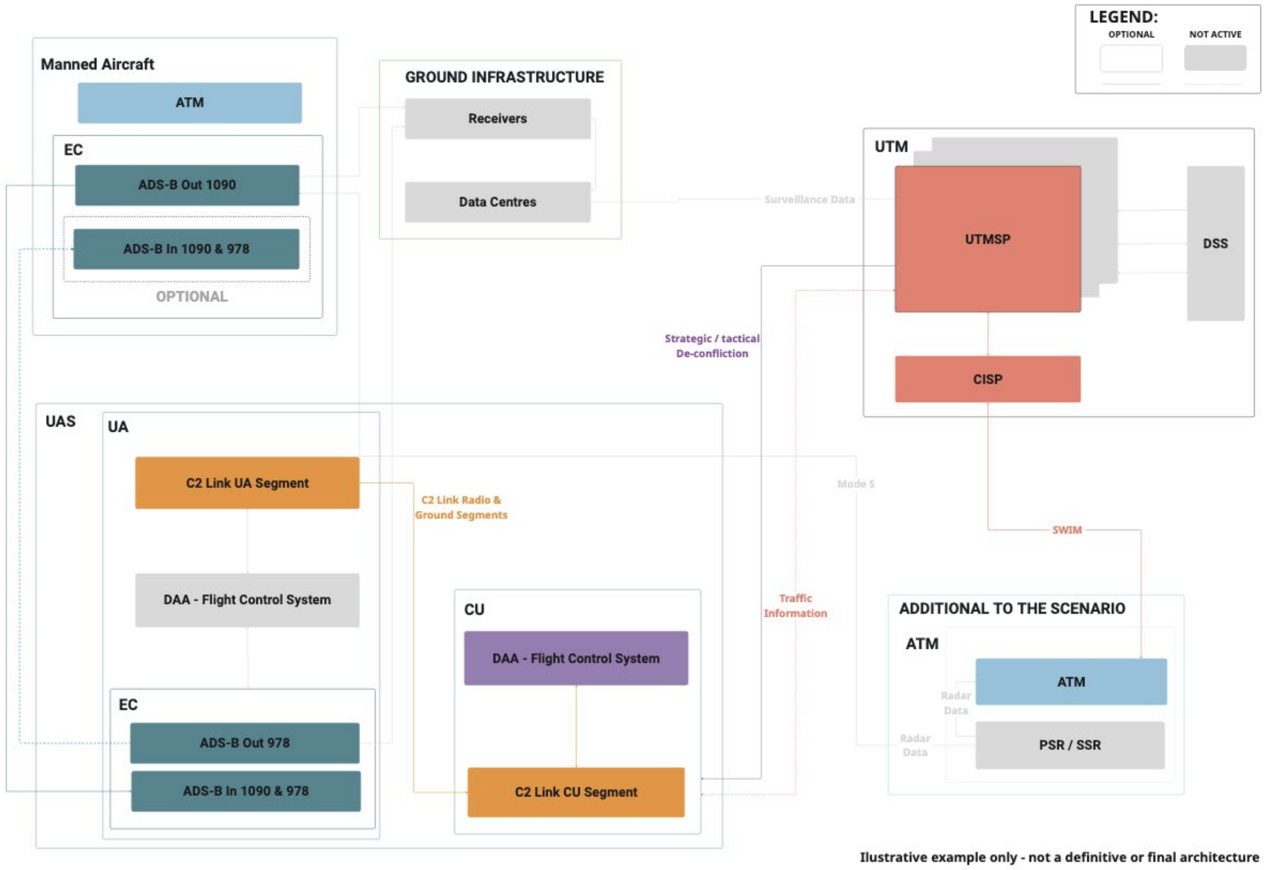

Figure 15. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Multiple UAS Operators in Uncontrolled Airspace (LL2)

Overview and Context

Scenario Description

3.107 **DISCLAIMER**: This scenario is only possible in the future (beyond 2028) with a more mature DAA solution in place and is listed here only as an outlook for future development and improvements. This is outside the medium-term objective of enabling more BVLOS operations in UK airspace and is not currently the focus of the FoF programme.

3.108 This scenario covers routine BVLOS operations performed by multiple operators in a rural Class G (uncontrolled) environment up to 500 ft AGL, e.g. last-mile delivery with multiple operators. With no temporary airspace structure in place, the operation relies on cooperative surveillance, a permanent ADS-B TMZ, and automated air-based DAA to maintain safety.

3.109 Traffic density determines whether UTM services are engaged to coordinate flows and manage shared volumes of activity. This enables scalable rural delivery operations beyond 2028 without the need for segregation.

SCENARIO LL2 - REPRESENTATION

UAS BVLOS delivery operation with multiple UAS operators in Class G airspace

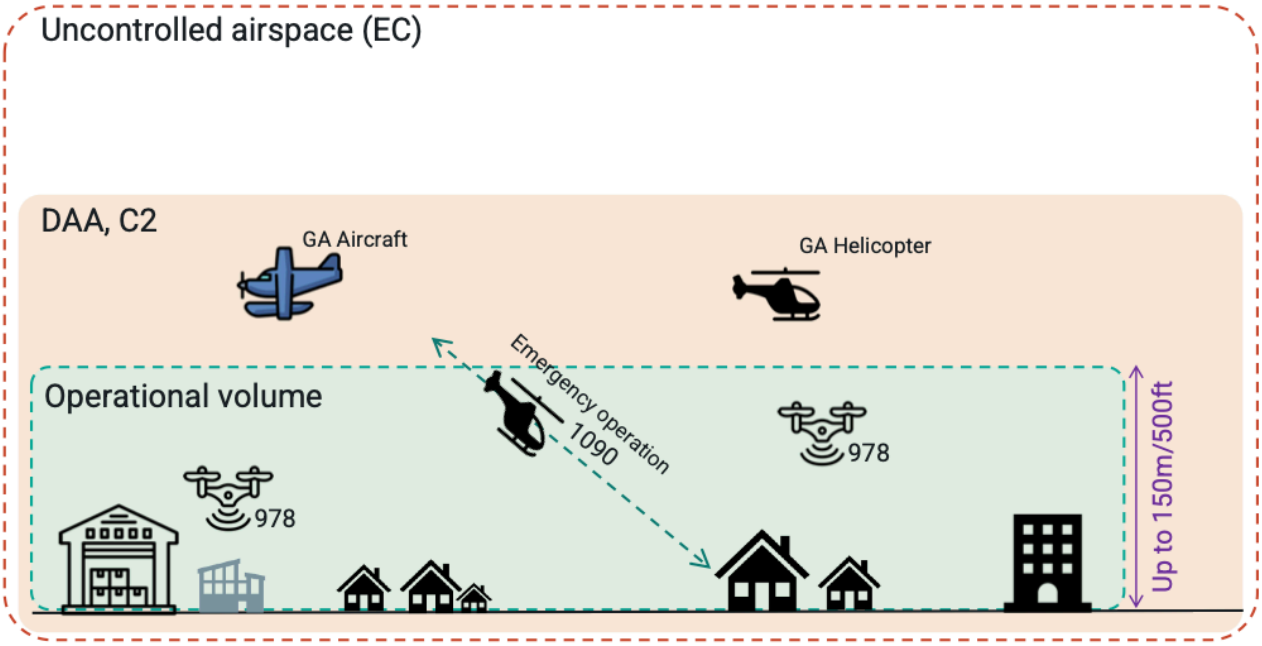

Figure 16. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.110 Airspace Class: Class G (Uncontrolled).

3.111 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-c.

3.112 BVLOS operations are only possible by complying with DAA requirements for ARC-c or by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.113 The operational description implies the initial ARC is ARC-c. Without the use of a temporary airspace structure, the ARC does not change, although the residual ARC is reduced to ARC-a with the implementation of full DAA capabilities and the assumed entry into force of the EC Mandate.

3.114 The use of strategic mitigations is in place:

- Progress toward 2028 and beyond: Use of SUA is not required.
- Other airspace requirements, defining a TMZ[43] (With an EC mandate in force, the establishment of TMZs will not be necessary)
- Pre-agreement of any UTM services to be used in-flight:
  - UTM Services are based on UA traffic density.

3.115 The use of tactical mitigations is in place:

- DAA capability[44]
- Carriage of EC out
- Monitoring of local traffic

Scenario Considerations

3.116 Airspace and Air Traffic Management

- Manned aircraft generally operate above 500 ft AGL, except during take-off, landing, emergency operations and other specified activities, military aviation may not conform to this assumption.
- If requested, a NOTAM ensures that other users are aware of the UAS operation.
- Operations rely on cooperative surveillance and self-separation.
- No routine ANSP interaction is required.

3.117 Altimetry Layers

- UAS operates up to 500 ft AGL.
- Manned aircraft generally operate above 500 ft AGL, except during take-off, landing, emergency operations and other specified activities, military aviation may not conform to this assumption.

3.118 Airspace Authorisation and Flight Planning

- Flight authorisation is managed via UTM.
- Strategic deconfliction is mandatory.

[43] UK SORA Annex C 1.14 "…in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment".

[44] information Only Display (ground based) DAA as per DAA policy concept (cooperative traffic only), in line with residual ARC

3.119 Electronic Conspicuity (EC)

- EC mandate in place (expected 2028-2029) imposing mandatory ADS-B Out equipage for manned aircraft. ADS-B in/out 978 MHz (UAS) and in 1090 MHz (manned) with supporting AMC and GM.
- UAS must broadcast and receive ADS-B In & Out signals.
- Manned aircraft must broadcast an ADS-B Out signal.
- Potentially, manned aircraft would include optional ADS-B in receivers, having the possibility of receiving ADS-B Out signals from other traffic, improving their situational awareness.

3.120 Unmanned Aircraft System Traffic Management (UTM)

- UTM provides flight authorisation and strategic and tactical deconfliction.
- UTM is the primary coordination mechanism between operators.

3.121 Detect and Avoid (DAA)

- DAA-equipped UAS autonomously detects an encounter. Avoidance manoeuvres are either autonomously conducted by the UAS or commanded by the remote pilot in command via C2 Link.
- UAS avoidance manoeuvres prioritised per DAA policy & guidance standards.

3.122 Right-of-Way Rules

- Management of operational prioritisation, including emergency situations, is addressed through established operational procedures and coordination mechanisms, while right-of-way requirements continue to be applied in accordance with UK SERA rules.
- UAS respond via DAA and procedural rules.

3.123 Non-Nominal and Contingency

- UTM-supported contingencies include rerouting and termination.
- Loss of EC or DAA capability triggers fail-safe behaviours.

SCENARIO LL2 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario LL2

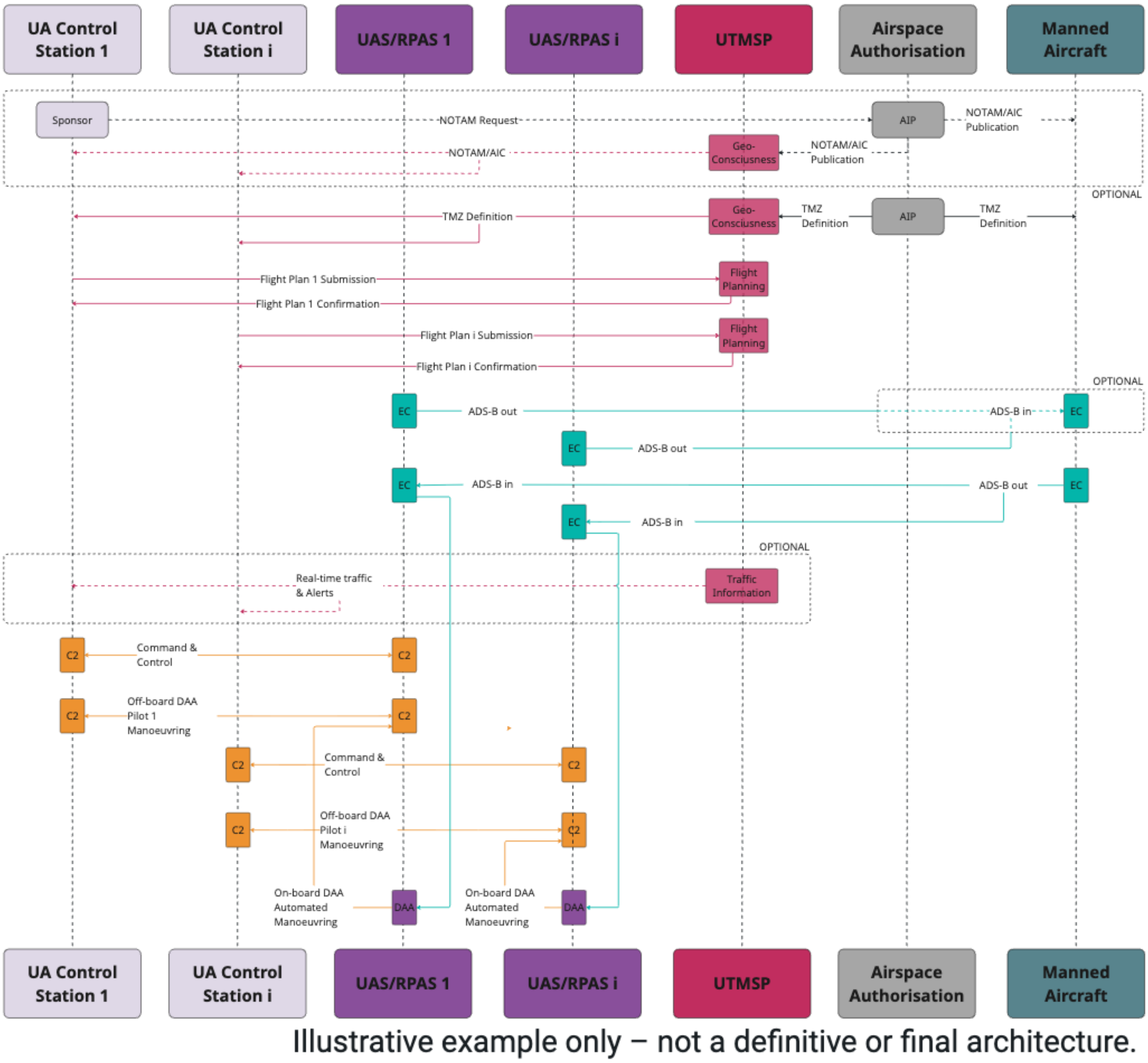

Figure 17. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.124 Electronic Conspicuity (EC)

- Permanent ADS-B-based cooperative environment supported by a TMZ, or EC mandate in force, with all unmanned aircraft equipped with ADS-B In/Out.

3.125 Detect and Avoid (DAA)

- Automated onboard DAA capabilities approved for ARC-c environments shall be implemented.

3.126 Command and Control (C2) Link

- Highly reliable and resilient C2 Link approved for advanced BVLOS operations.

3.127 UTM Services

- UTM services shall be used for flight authorisation and coordination, with additional services applied based on UA traffic density.

3.128 Navigation and Containment

- GNSS-based navigation, geofencing, and terrain-aware flight capability.

Optional System Capabilities

3.129 Ground Infrastructure

- Multi-sensor ground-based surveillance to enhance cooperative and non-cooperative traffic awareness.

Scenario Technical Architecture

SCENARIO LL2 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario LL2

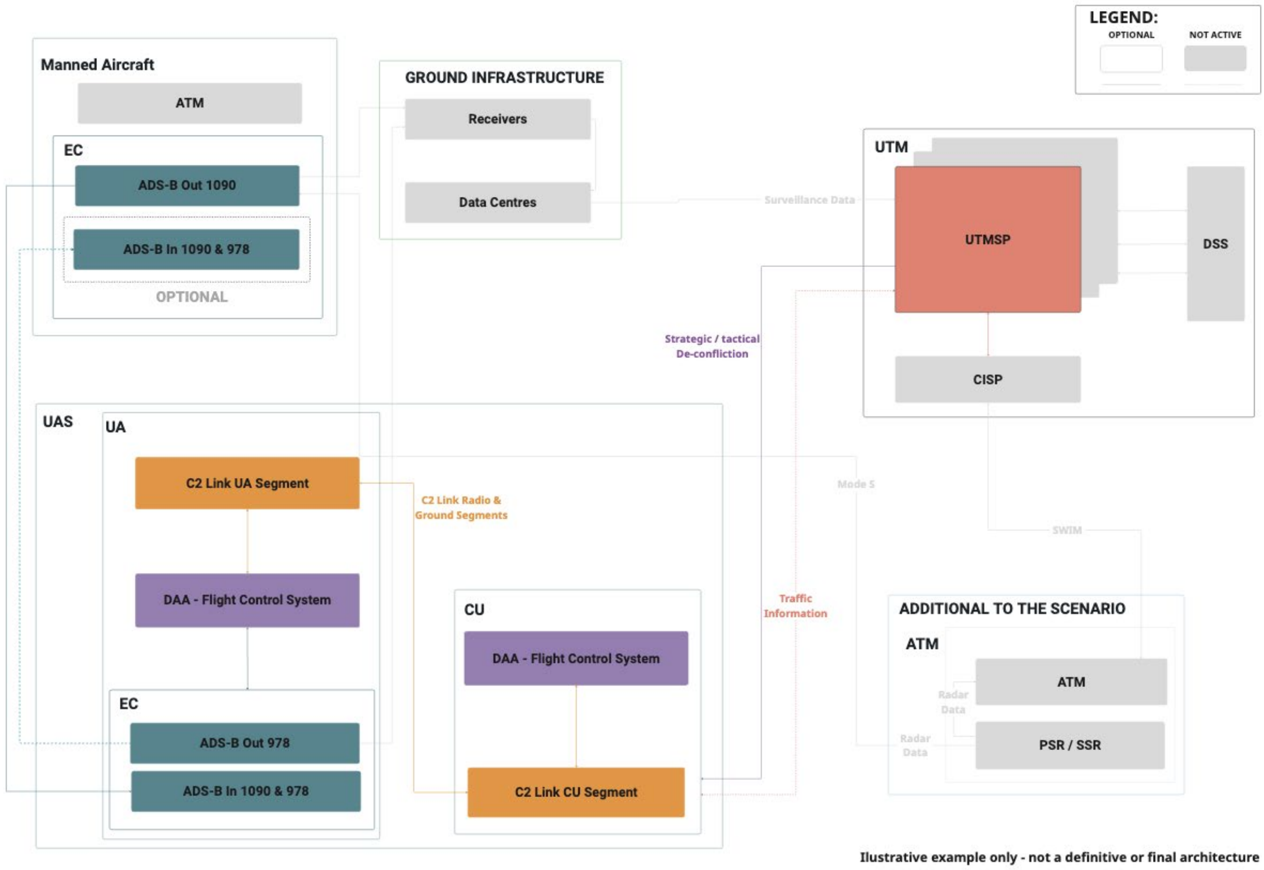

Figure 18. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Operational Scenarios: Fully Integrated

3.130 Today, fully integrated BVLOS operations in the UK (FI0) are primarily conducted using Temporary Danger Areas (TDA). These airspace structures serve as essential stepping stones, allowing the industry to generate safety data and test new technologies.

3.131 However, this current model faces significant challenges regarding scalability:

- Airspace Change Process (CAP1616): Establishing these temporary volumes requires a formal Airspace Change Proposal (ACP). This process is often time-consuming and costly, making it impractical for routine commercial use.

- Limited Flexibility: These structures are often "bespoke" and tied to specific, short-duration missions. The rigid nature of current segregation means it is not yet possible to support multiple concurrent operators or widespread urban logistics without significant administrative overhead.
- Inefficient Airspace Use: segregation blocks volumes of airspace for other users, which is contrary to the long-term goal of a “Fully Integrated Scenario” where drones and crewed aircraft coexist safely.

Segregated Operations (FI0)

Overview and Context

Scenario Description

3.132 This scenario describes a segregated operation conducted up to 500 ft AGL in Class G (uncontrolled) airspace, e.g. maritime inspection over coastal waters.

3.133 The activity is protected by a Temporary Danger Area (TDA), ensuring that unmanned flights remain separated from other airspace users. With the airspace fully segregated while the TDA is active, no DAA capability is required.

3.134 The nearby ANSP supports the operation by providing information on TDA status and, when inactive, coordinates possible crossings for other types of traffic.

3.135 The setup enables simple, safe, and predictable UAS BVLOS inspection missions without the need for UTM services.

SCENARIO FI0 - REPRESENTATION

UAS BVLOS operation performing maritime inspection operation in Class G airspace

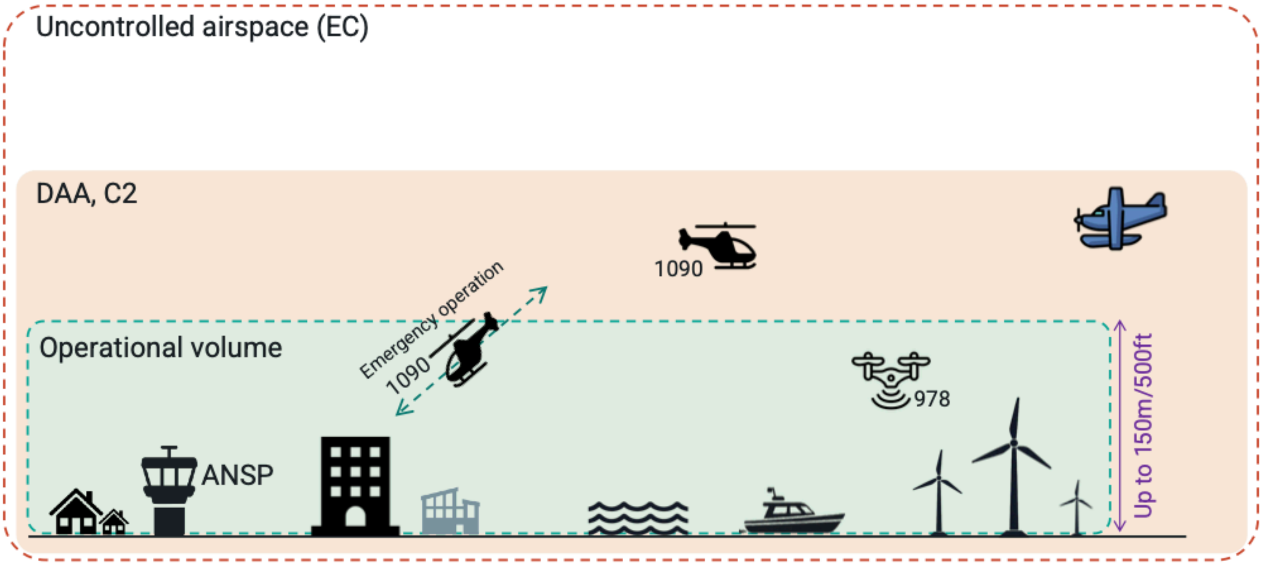

Figure 19. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.136 Airspace Class: Class G (uncontrolled) – Coastal waters location.

3.137 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-c.

3.138 BVLOS operations are only possible by complying with DAA requirements for ARC-c or by segregation (Strategic Mitigation), providing a residual ARC-a as is relevant to this scenario.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.139 The operational description implies that the initial ARC is ARC-c, and, through strategic mitigations, it is reduced to residual ARC-a.

3.140 The use of strategic mitigations is in place:

- Required "Special Use Airspace", as a Temporary Danger Area (TDA)

3.141 Optional mitigations to the scenario to enhance scalability under the UK SORA framework

- Carriage of EC in/out.
- Monitoring of local traffic.
- Pre-agreement of any UTM services to be used in-flight.

Scenario Considerations

3.142 Airspace and Air Traffic Management

- Operations are conducted within segregated airspace (e.g. TDA).
- No interaction with crewed traffic within the volume.

3.143 Altimetry Layers

- UAS operates up to 500 ft AGL, contained within a specific TDA.
- Manned aircraft generally operate above 500 ft AGL, except during take-off, landing, emergency operations and other specified activities, military aviation may not conform to this assumption.

3.144 Airspace Authorisation and Flight Planning

- Access is authorised via the segregated airspace approval process.

3.145 Electronic Conspicuity (EC)

- EC is optional and informational.

3.146 Unmanned Aircraft System Traffic Management (UTM)

- UTM services are used depending on UA traffic density, with the RP monitoring local traffic to initiate avoidance manoeuvres.
- UTM is optional and limited to planning or notification.

3.147 Detect and Avoid (DAA)

- DAA is not required due to segregation.

3.148 Right-of-Way Rules

- Management of operational prioritisation, including emergency situations, is addressed through established operational procedures and coordination mechanisms, while right-of-way requirements continue to be applied in accordance with UK SERA rules.
- UAS respond via DAA and procedural rules.
- Emergency air access is managed by suspending segregation if required.

3.149 Non-Nominal and Contingency

- Contingencies are managed within the segregated framework.

SCENARIO FI0 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario FI0

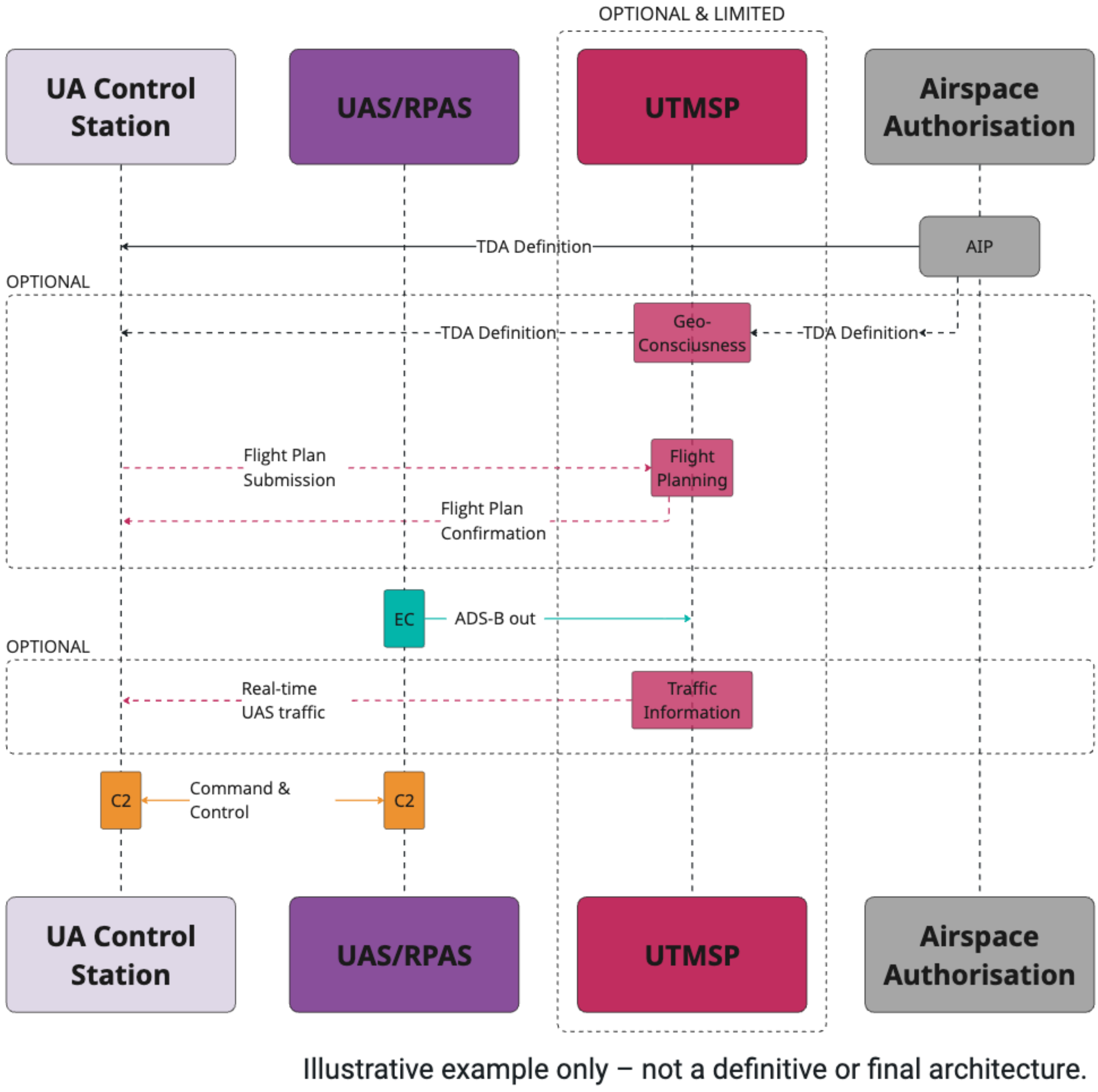

Figure 20. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.150 Special Use Airspace (SUA)

- Operations shall be conducted within a TDA or equivalent segregated structure.

3.151 Command and Control (C2) Link

- Secure and reliable C2 Link approved for the applicable SAIL.

3.152 Navigation and Containment

- GNSS-based navigation and geofencing to ensure containment within the segregated volume.

Optional System Capabilities

3.153 Electronic Conspicuity (EC)

- Optional carriage of EC to enhance situational awareness.

3.154 UTM Services

- Optional use of basic UTM services for information purposes only.

Scenario Technical Architecture

SCENARIO FI0 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario FI0

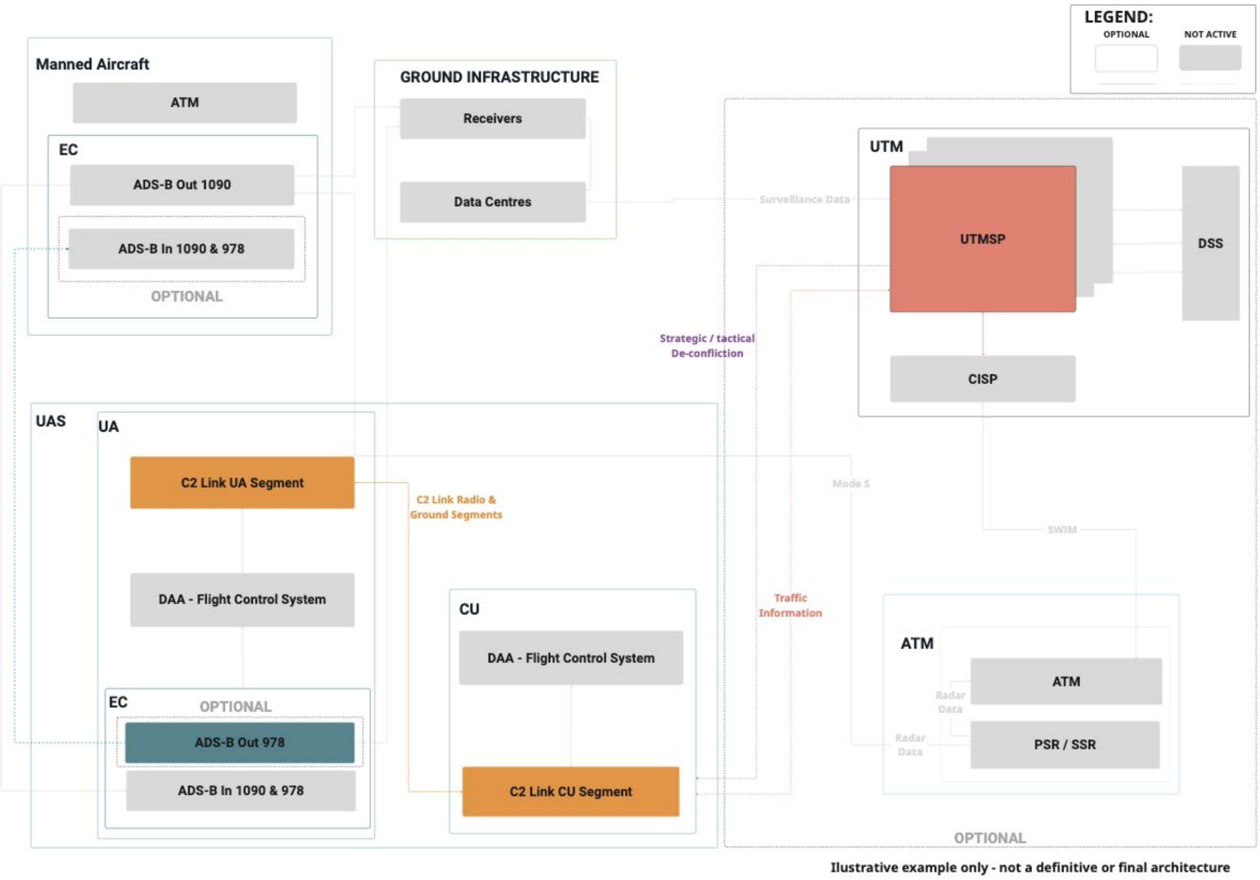

Figure 21. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Specific Volumes with Bespoke Entry Conditions (FI1)

Overview and Context

Scenario Description

3.155 This scenario describes survey operations conducted at 750 ft AGL within rural Class D (controlled) airspace, e.g. wildlife or environment survey.

3.156 The activity takes place inside a defined TRA, creating a structured and predictable operating volume for unmanned flights while still allowing controlled access for crewed aircraft under bespoke entry conditions.

3.157 A permanent TMZ ensures cooperative visibility across all users, while DAA requirements remain limited to residual ARC-b environments.

3.158 With ANSP oversight and controlled TRA access, the operation becomes safe and scalable under the 2027 integrated airspace model.

SCENARIO FI1 - REPRESENTATION

UAS BVLOS wildlife or environment survey in Class D airspace

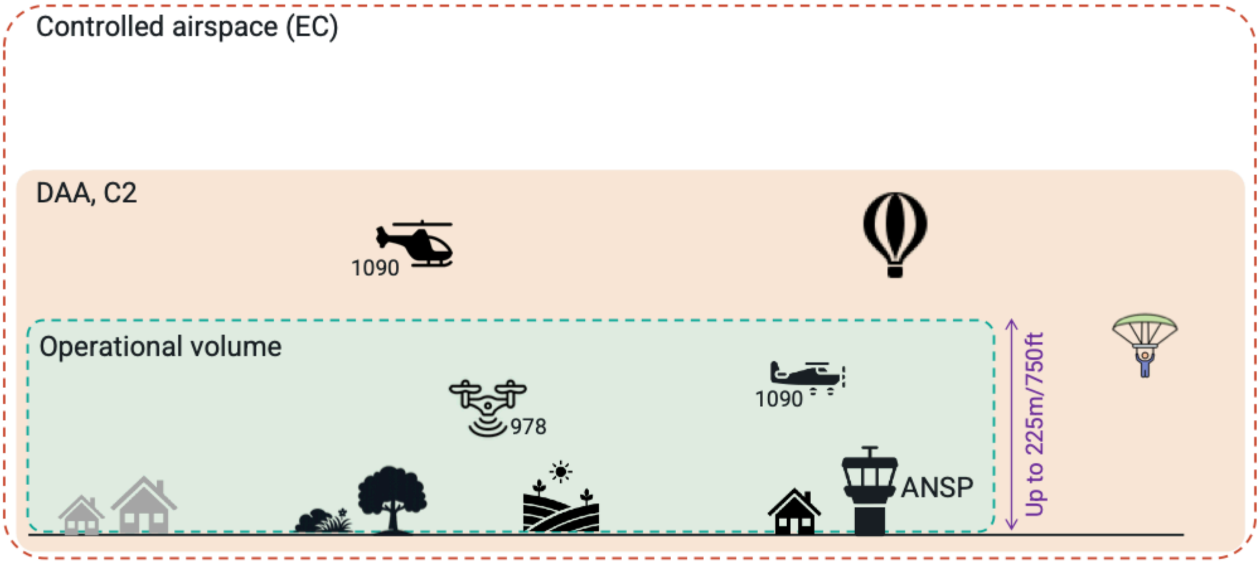

Figure 22. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.159 Airspace Class: Class D (Controlled).

3.160 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-c.

3.161 BVLOS operations are only possible by complying with DAA requirements for ARC-c or by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.162 The operational description implies the initial ARC is ARC-c, and by strategic mitigations, it is reduced to residual ARC-b.

3.163 The use of strategic mitigations is in place:

- Special Use Airspace (SUA), defining TRA, that could be permanent.
- Other airspace requirements, defining a TMZ.[45]
- Based on ANSP coordination:
  - The nearby ANSP provides oversight and TRA access coordination, ensuring the operation remains safe and scalable.[46]

3.164 The use of tactical mitigations is in place:

- DAA capability[47]
- Carriage of EC out[48]
- Monitoring of local traffic

3.165 Optional mitigations to the scenario to enhance scalability under the UK SORA framework:

- Pre-agreement of any UTM services to be used in-flight.

Scenario Considerations

3.166 Airspace and Air Traffic Management

- Operations are conducted within defined volumes of controlled airspace subject to bespoke entry conditions (e.g. TRA and/or TMZ), enabling coexistence between unmanned and manned aircraft.
- Coordination with the ANSP supports access management, prioritisation of crewed traffic, and resolution of potential conflicts within the volume.
- Temporary airspace structures may be used to support early integrated operations while policy and system maturity increase.

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[45] UK SORA Annex C 1.14 "…in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment".

[46] Crewed TRA entry conditions, as 1 - carriage and operation of ADS-B Out as described in CAP3140; and 2 - airspeed 140kts or less.

[47] Information Only Display (ground based) DAA as per DAA policy concept (cooperative traffic only), in line with residual ARC.

[48] In line with the specifications described in CAP3140.

- ATC interaction follows agreed, scenario-specific procedures.

3.167 Altimetry Layers

- Operations are conducted within defined vertical limits appropriate to the specific volume, typically at higher altitudes than low-level urban scenarios.
- Altitude stratification and buffers are used to support predictable separation between manned and unmanned aircraft.
- Vertical constraints are defined in the airspace authorisation and reflected in flight planning and UTM/ATM coordination.

3.168 Airspace Authorisation and Flight Planning

- An OA is obtained through UK SORA, with the initial ARC reduced using strategic mitigations associated with the defined volume and entry conditions.
- Flight planning includes submission of intended routes, altitudes, and timing, and is coordinated with the ANSP and, where available, UTMSP.
- Access approval is contingent on compliance with the bespoke entry conditions applicable to the volume.

3.169 Electronic Conspicuity (EC)

- Cooperative EC equipage is required for UAS operating within the volume, in accordance with applicable EC policy.
- Crewed aircraft comply with EC equipage requirements defined as part of the bespoke entry conditions.
- EC supports shared situational awareness for both UTM and ATM functions.

3.170 Unmanned Aircraft System Traffic Management (UTM)

- UTM services may be used to support flight planning, coordination, and information sharing within the defined volume.
- UTM–ATM interfaces support the exchange of operational status, airspace constraints, and approved trajectories.
- Use of UTM services enhances scalability but does not fully replace bespoke procedures at this stage.

3.171 Detect and Avoid (DAA)

- DAA is implemented through an Information-Only Display system meeting ARC-b TMPRs. The system provides traffic advisories to support pilot-in-the-loop tactical deconfliction, without issuing automated or directive avoidance manoeuvres.

- Tactical mitigation remains a combination of procedural responses and emerging technical support.
- Full reliance on automated DAA is not yet assumed, existing a dependency with C2 Link.

3.172 Right-of-Way Rules

- The management of prioritisation, including emergency air situations, is addressed by ATC in accordance with UK SERA right-of-way rules.
- UAS operations are paused, rerouted, or terminated as required to accommodate emergency air activity within or near the volume.

3.173 Non-Nominal and Contingency

- Contingency procedures are defined for loss of C2, navigation degradation, or loss of EC, and are coordinated with the ANSP where required.
- Predefined safe termination or exit procedures are applied if conditions no longer support the assumptions underpinning the scenario.
- Escalation and notification mechanisms are defined as part of the bespoke operating procedures.

SCENARIO FI1 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario FI1

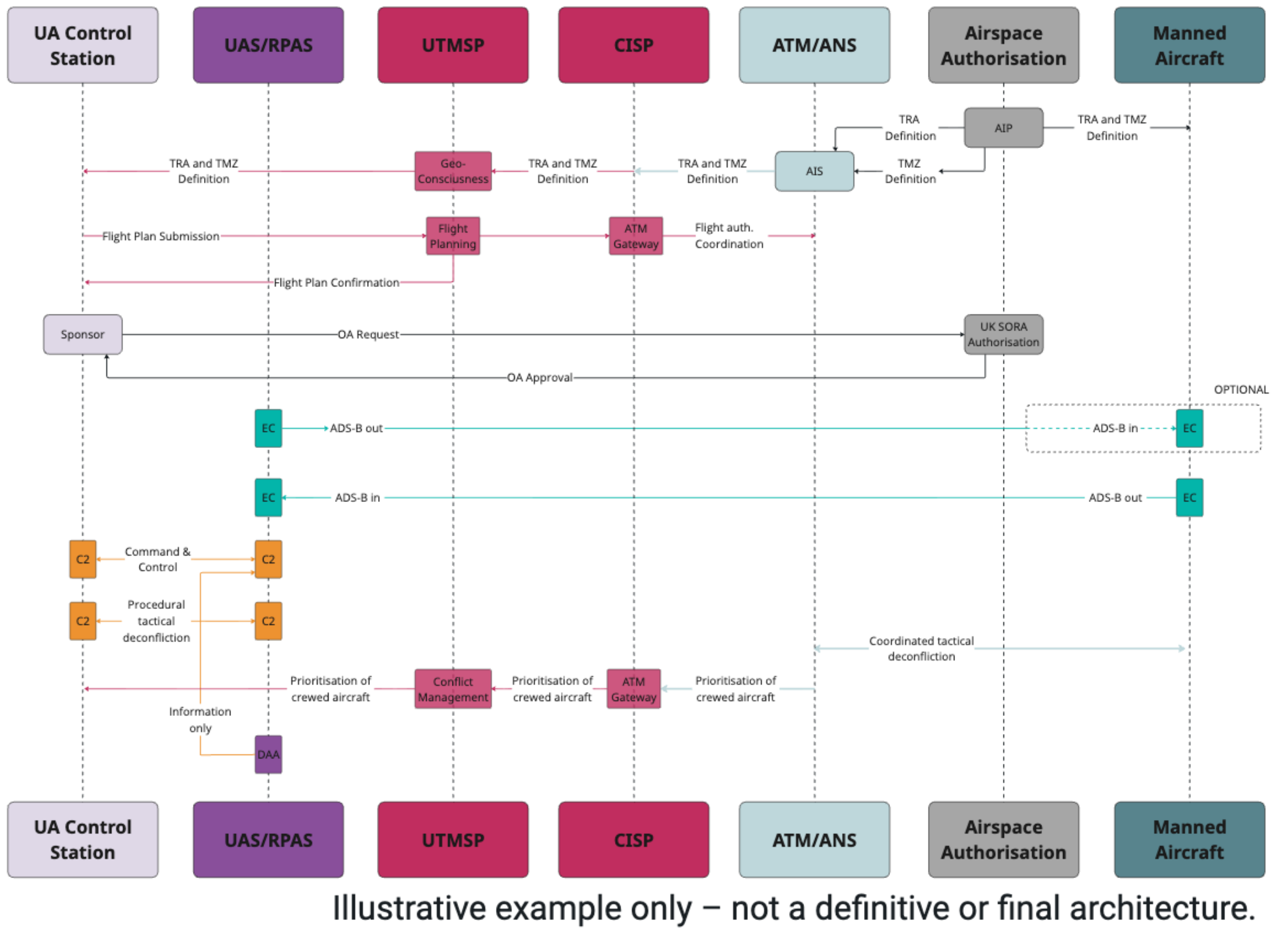


Figure 23. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.174 Electronic Conspicuity (EC)

- Cooperative EC environment supported by ADS-B In/Out equipage for unmanned aircraft and applicable equipage requirements for crewed aircraft.

3.175 Detect and Avoid (DAA)

- DAA capabilities approved for operations shall be implemented to support tactical mitigation within the defined operational volume.

3.176 Command and Control (C2) Link

- Secure and resilient C2 Link approved for the applicable SAIL.

3.177 Special Use Airspace and ANSP Coordination

- Operations conducted within TRA/TMZ with bespoke entry conditions managed by the ANSP.

Optional System Capabilities

3.178 UTM Services

- Optional strategic coordination services to enhance scalability.

Scenario Technical Architecture

SCENARIO FI1 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario FI1

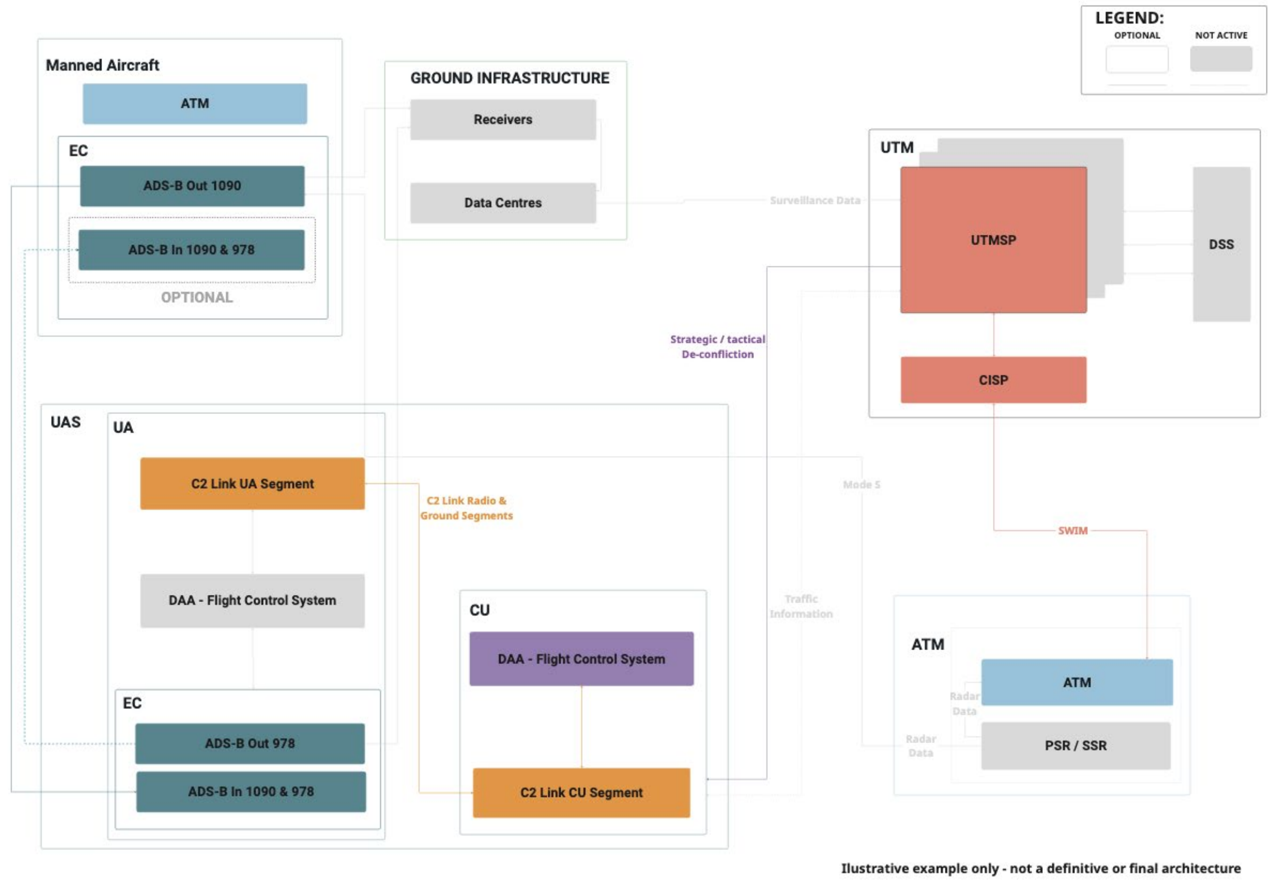


Figure 24. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

UAS Operations in Controlled Airspace (FI2)

Overview and Context

Scenario Description

3.179 This scenario describes operations conducted up to 500 ft AGL within urban Class D airspace, with the absence of temporary airspace structures, e.g. point-to-point freight delivery operations.

3.180 A permanent ADS-B TMZ ensures cooperative visibility for both unmanned and manned aircraft in accordance with CAP3140, fostering a collaborative environment.

3.181 Separation from crewed traffic is provided through a UTM-delivered service, received only by the UA, adding an extra safety layer that supports onboard DAA.

3.182 As traffic density increases, activity is coordinated with the ANSP via UTM flight authorisation and supporting UTM services, enabling multiple operators to conduct routine freight operations safely and efficiently.

SCENARIO FI2 - REPRESENTATION

UAS BVLOS delivery operation in Class D airspace

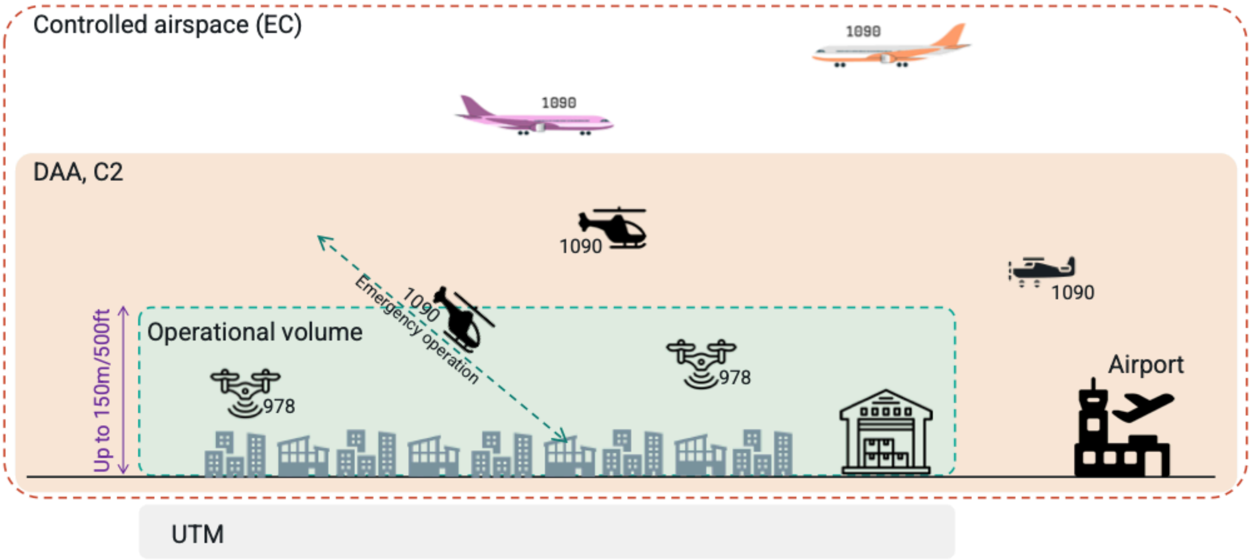


Figure 25. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.183 Airspace Class: Class D (controlled).

3.184 Air Risk Class: Based on UK SORA, the initial ARC applicable to this environment is ARC-b.

3.185 BVLOS operations are only possible by complying with DAA requirements for ARC-b or by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.186 The operational description implies the initial ARC is ARC-b, and no temporary airspace structure is used; the residual ARC remains ARC-b.

3.187 The use of strategic mitigations is in place:

- Progress toward 2028: No requirements to use SUA.
- Other airspace requirements, defining a TMZ.[49]
- Pre-agreement of any UTM services to be used in-flight:
  - “UA-to-manned” separation service, received by UA only.
  - Activity coordinated with ANSP and other UTMSP via the flight authorisation service, based on UA traffic density.

3.188 The use of tactical mitigations is in place:

- DAA capability[50]
- Carriage of EC out
- Monitoring of local traffic

Scenario Considerations

3.189 Airspace and Air Traffic Management

- Operations are conducted routinely in controlled airspace without reliance on temporary or bespoke airspace structures.
- UAS are integrated alongside crewed aircraft using standardised ANSP procedures and supporting UTM services.
- ATC interaction is routine and follows established controlled airspace practices.

3.190 Altimetry Layers

- Up to 500 ft AGL.

[49] UK SORA Annex C 1.14 ”…in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment”.

[50] Information Only Display (ground based) DAA as per DAA policy concept (cooperative traffic only), in line with residual ARC.

- Operations are conducted within standard altitude bands applicable to the controlled airspace environment.
- Vertical separation is managed through flight planning, ATC clearances, and system-based constraints.
- Altitude management supports predictable integration with crewed traffic flows.

3.191 Airspace Authorisation and Flight Planning

- Flight authorisation is supported through UTM services and coordinated with ATM systems.
- Strategic deconfliction is applied during planning to account for airspace constraints, traffic demand, and priority operations.
- Approved trajectories are shared between UTM and ATM to ensure common situational awareness.

3.192 Electronic Conspicuity (EC)

- EC equipage is mandatory for UAS and crewed aircraft in accordance with controlled airspace requirements.
- Cooperative surveillance forms a core element of integrated traffic management.
- EC data supports both tactical and strategic functions.

3.193 Unmanned Aircraft System Traffic Management (UTM)

- UTM provides flight authorisation, strategic deconfliction, and information services to UAS operators.
- UTM–ATM integration enables coordinated management of mixed traffic.
- The level of UTM service provision scales with traffic density.

3.194 Detect and Avoid (DAA)

- DAA capabilities approved to support the applicable residual ARC are used routinely.
- DAA provides the primary tactical mitigation for MAC risk where ATC separation is not directly provided to the UAS.
- Automated responses may be supported by procedural oversight.

3.195 Right-of-Way Rules

- Management of prioritisation, including emergency air situations, is addressed by ATC in accordance with UK SERA right-of-way rules.

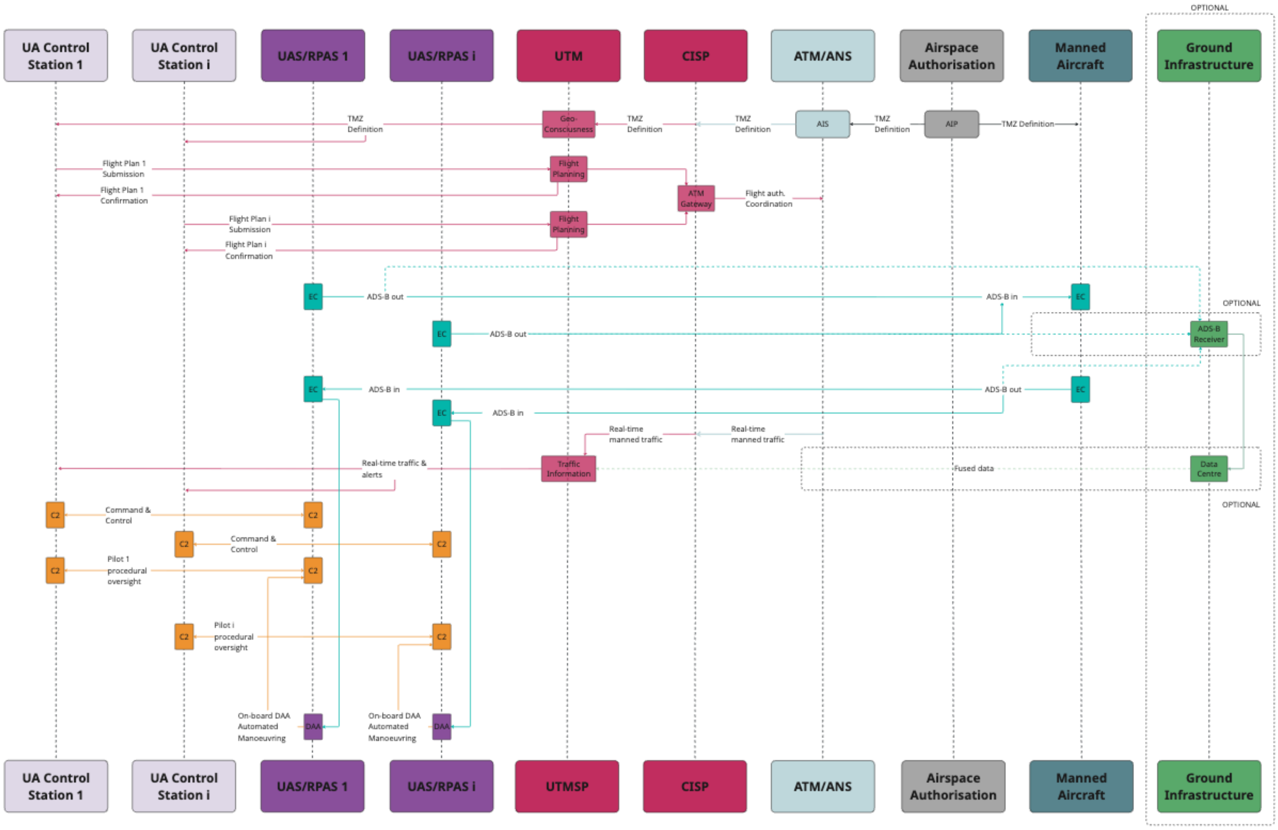
- UAS respond to emergency air traffic through DAA-supported manoeuvres or ATC/UTM instructions.

3.196 Non-Nominal and Contingency

- Non-nominal situations are managed through coordinated UTM–ATM procedures.
- Loss of critical systems may result in rerouting, holding, or termination as directed.
- System resilience and recovery procedures are designed to support routine operations at scale.

SCENARIO FI2 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario FI2



Illustrative example only – not a definitive or final architecture.

Figure 26. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.197 Electronic Conspicuity (EC)

- Permanent ADS-B-based cooperative environment for both unmanned and crewed aircraft.

3.198 UTM Services

- UTM-delivered flight authorisation and separation services provided to the unmanned aircraft, replacing the need for onboard DAA.

3.199 Command and Control (C2) Link

- Highly reliable, secure, and resilient C2 Link.

3.200 ANSP Integration

- Coordination between UTMSP and ANSP to support controlled airspace operations.

Optional System Capabilities

3.201 Ground Infrastructure

- Enhanced surveillance and data fusion to support higher traffic densities.

Scenario Technical Architecture

SCENARIO FI2 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario FI2

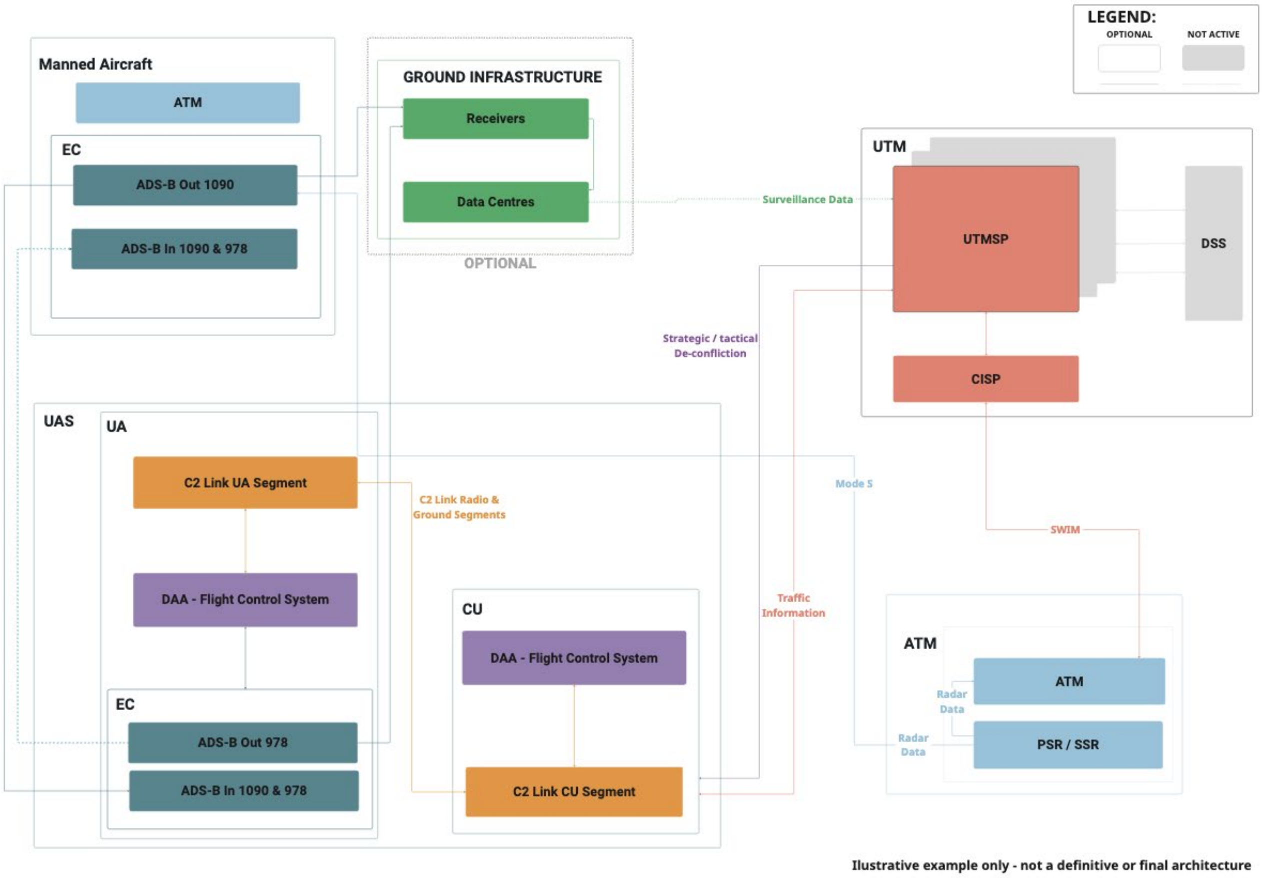


Figure 27. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

UAS Operations in Controlled and Uncontrolled Airspace (FI3)

Overview and Context

Scenario Description

3.202 **DISCLAIMER**: This scenario is only possible in the future (beyond 2028) with a more mature DAA solution in place and is listed here only as an outlook for future development and improvements. This is outside the medium-term objective of enabling more BVLOS operations in UK airspace and is not currently the focus of the FoF programme.

3.203 This scenario describes operations flown along fixed routes at around 1,200 ft AGL, across both controlled and uncontrolled airspace, e.g. middle-mile logistics between distribution centres.

3.204 In the urban Class D (controlled) segment, located near airfields with IFPs, the initial ARC-d is reduced to residual ARC-c through operational restriction by boundary, while in the rural Class G (uncontrolled) portion, the initial ARC-c remains unchanged.

3.205 Operations rely on automated, ground-based multi-sensor DAA capable of detecting both cooperative and uncooperative traffic, providing the tactical mitigation required at ARC-c.

3.206 Activity is coordinated with the ANSP via UTM flight authorisation, with additional UTM services applied based to traffic density, enabling predictable, scalable logistics movements across mixed airspace environments.

SCENARIO FI3 - REPRESENTATION

UAS BVLOS logistic operation in Class G and D airspace

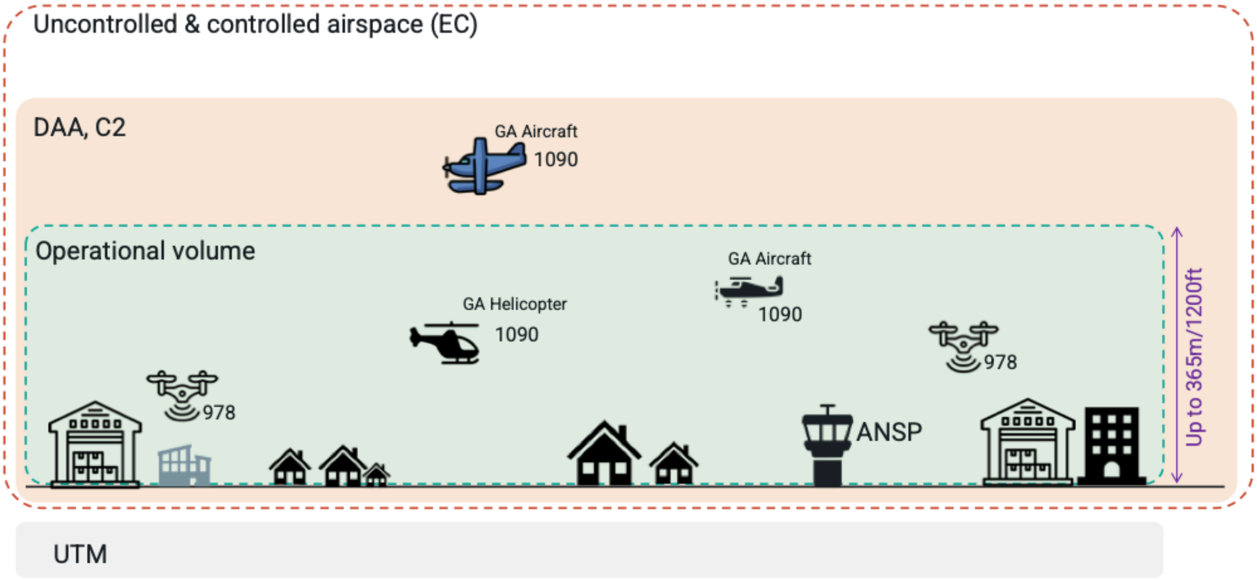


Figure 28 - UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Current Regulatory and Operational Context

3.207 Airspace Class: Class G (uncontrolled) and Class D (controlled).

3.208 Air Risk Class: Based on UK SORA, the highest initial ARC applicable to this environment is ARC-d.

3.209 BVLOS operations are only possible by complying with DAA requirements for ARC-b or by segregation (Strategic Mitigation), providing a residual ARC-a.

Operations Authorised through UK SORA Enhanced by Future ATM/ANS

3.210 The operational description implies the higher initial ARC is ARC-d, and by strategic mitigations, it is reduced to residual ARC-c.

3.211 The use of strategic mitigations is in place:

- Progress toward 2028 and beyond: SUA not required.
- Other airspace requirements, defining a TMZ[51] or EC mandate, are in place.
- Pre-agreement of any UTM services to be used in-flight:
  - "UA-to-manned" Separation Service, received by UA only.
  - Activity coordinated with ANSP and other UTMSP via Flight Authorisation Service, based on UA traffic density.

3.212 The use of tactical mitigations is in place:

- DAA capability[52]
- Carriage of EC out
- Monitoring of local traffic

Scenario Considerations

3.213 Airspace and Air Traffic Management

- Operations span controlled and uncontrolled airspace without reliance on temporary structures.
- Integration relies on harmonised procedures, UTM services, and ATM interfaces across airspace classes.
- ATC interaction is applied where required in controlled airspace, and transitions are managed seamlessly.

3.214 Altimetry Layers

- Fixed routes around 1200 ft AGL.
- Altitude constraints are dynamically managed through flight planning and in-flight updates to support safe transitions between controlled and uncontrolled environments.

3.215 Airspace Authorisation and Flight Planning

- Flight authorisation is managed through UTM services, incorporating airspace constraints from ATM systems.
- Strategic deconfliction is applied at a national or regional scale to support long-range operations.

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[51] UK SORA Annex C 1.14"…in compliance with alternative provisions prescribed for that particular airspace by the TMZ Controlling authority that will achieve a cooperative electronic conspicuity environment".

[52] Information Only Display (ground based) DAA as per DAA policy concept (cooperative traffic only), in line with residual ARC.

- Approved routes and constraints are dynamically updated as conditions change.

3.216 Electronic Conspicuity (EC)

- System-wide EC equipage is assumed for both unmanned and manned aircraft (EC mandate possibly in force).
- Cooperative surveillance underpins integrated operations across airspace classes.
- EC data supports strategic planning, tactical avoidance, and post-operational analysis.

3.217 Unmanned Aircraft System Traffic Management (UTM)

- UTM provides comprehensive services, including flight authorisation, strategic and tactical deconfliction, compliance monitoring, and dynamic rerouting.
- UTM–ATM interface is mature and supports real-time coordination.
- Service provision adapts to traffic density, complexity, and airspace type.

3.218 Detect and Avoid (DAA)

- DAA capabilities approved to ARC-c are used routinely, including the detection of cooperative and non-cooperative traffic.
- Automated avoidance functions are supported by UTM-provided information and constraints.
- DAA performance supports operations across mixed airspace environments.

3.219 Right-of-Way Rules

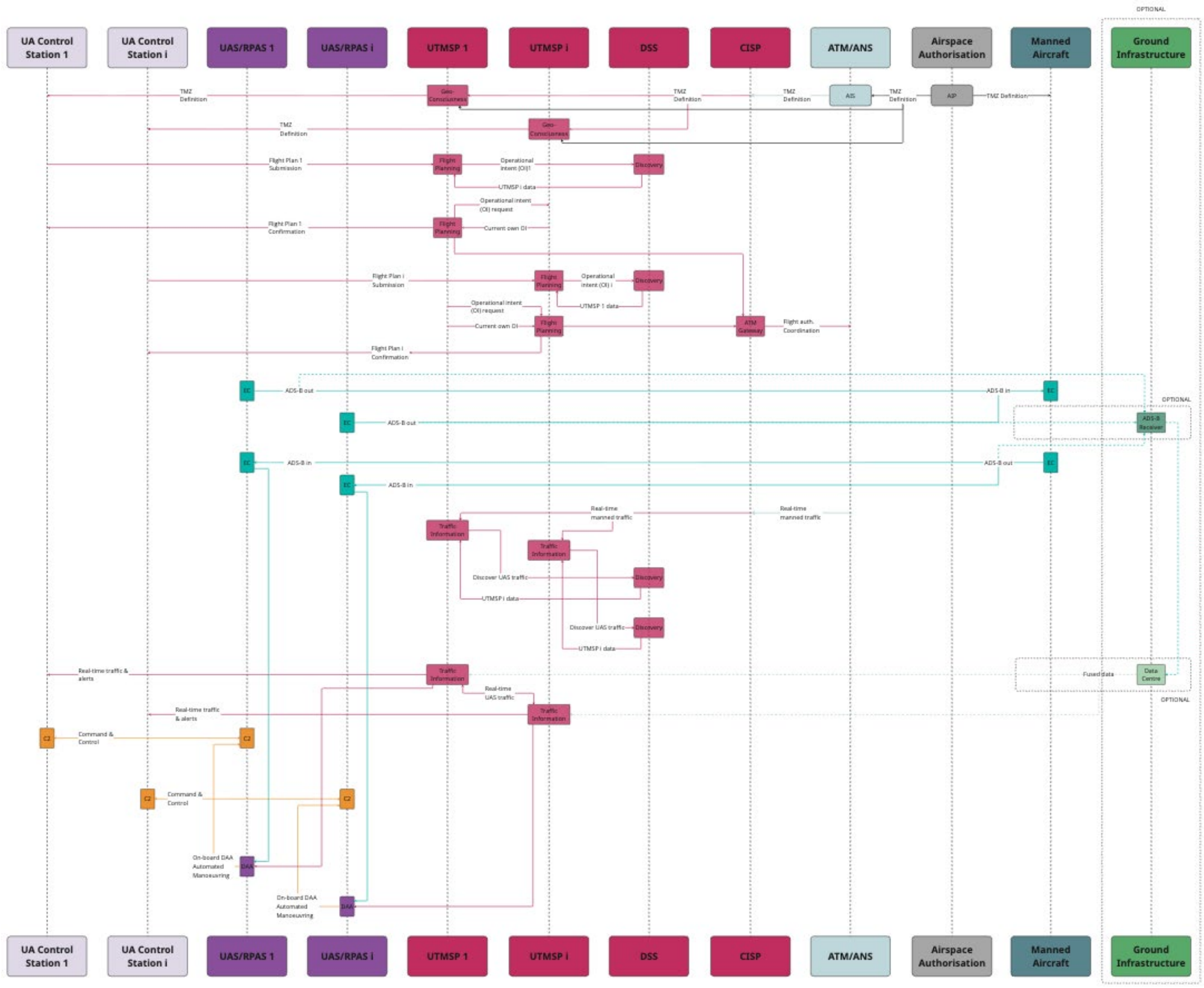
- Management of prioritisation, including emergency air situations, is addressed by ATC in controlled airspace in accordance with UK SERA right-of-way rules.
- UAS operations respond dynamically through DAA and UTM/ATM instructions to accommodate emergency air activity.

3.220 Non-Nominal and Contingency

- Contingencies are managed through system-wide coordination, including dynamic rerouting or safe termination.
- Loss of capability in one domain (e.g. C2, EC, UTM) triggers predefined fallback behaviours.
- Resilience measures support continued safe operation at the national scale.

SCENARIO FI3 - WORK-FLOW DIAGRAM

Workflow and information flow diagram for systems considered in scenario FI3



Illustrative example only – not a definitive or final architecture.

Figure 29. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

Systems for Safe Operation

Mandatory System Capabilities

3.221 Electronic Conspicuity (EC)

- Cooperative EC equipage across all participating aircraft.

3.222 Detect and Avoid (DAA)

- Automated, ground-based or airborne multi-sensor DAA capable of detecting cooperative and non-cooperative traffic, approved for ARC-c environments.

3.223 UTM Services

- Comprehensive UTM services, including flight authorisation, strategic and tactical deconfliction, and dynamic rerouting, are applied according to traffic density.

3.224 Command and Control (C2) Link

- Highly resilient, redundant C2 Link supporting long-range and cross-airspace operations.

3.225 ANSP and SWIM Integration

- Integrated coordination between UTM and ATM via CISP/SWIM to support mixed airspace operations.

Optional System Capabilities

3.226 Advanced Automation

- Predictive conflict management and automated contingency handling to support high-density operations.

Scenario Technical Architecture

SCENARIO FI3 – TECHNICAL ARCHITECTURE

System architecture proposal for scenario FI3

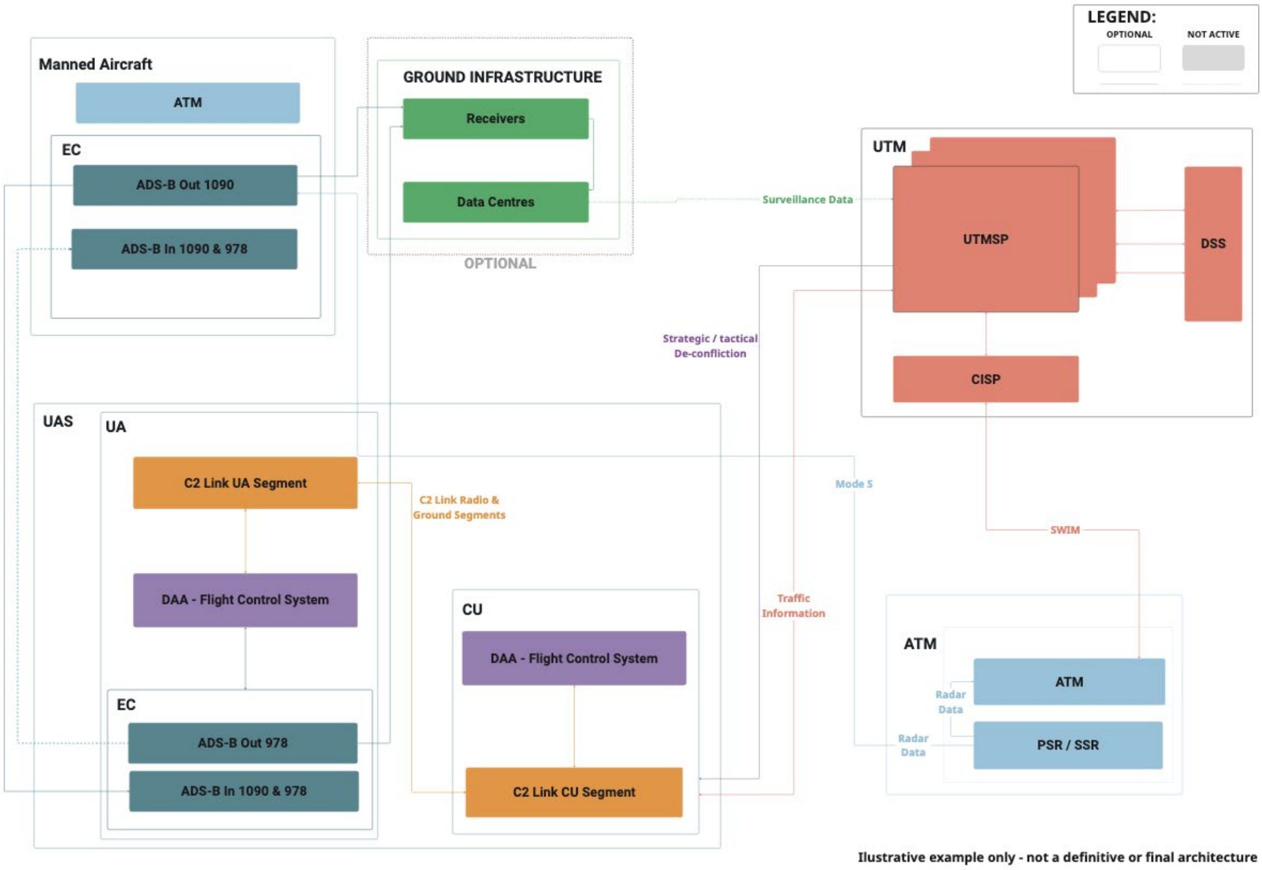


Figure 30. UK CAA Future ATM/ANS ConOps (Illustrative representation of the conceptual framework, showing example technical options and integration approaches as understood today; subject to evolution and not prescriptive)

APPENDIX A

Requirements

A1 The high-level requirements outlined in this section define the essential capabilities for the future structure of UK airspace, ensuring the safe and efficient integration of both manned and unmanned aviation. These requirements establish a framework for interoperability between emerging and existing systems, enabling a coordinated, scalable, and technology-driven airspace environment.

A2 Key focus areas include UTM, DAA, C2 Link, GI, EC, and SWIM, all of which will be critical in ensuring safe and efficient airspace operations. These elements must integrate seamlessly with ATM to support mixed-mode operations, maintaining alignment with regulatory frameworks and enabling a phased transition towards a more dynamic, automated airspace system.

A3 Requirements will be verified and validated through a combination of simulations, trials, and real-world assessments, ensuring that each component of the future airspace construct is robust, resilient, and operationally viable. The outcome will be a more integrated and adaptive airspace system that enables innovation while upholding the highest safety and efficiency standards.

Key Airspace Requirements

A4 **Iterative TRA/TMZ Development**: The TRA/TMZ framework shall be designed to support an iterative approach, allowing for continuous learning and refinement of the operational framework beyond 2027, in alignment with the Future ATM/ANS long-term objectives under the AMS.

A5 **Alternative SUA**: Other SUA beyond TRA/TMZ shall be considered to facilitate UAS integration, enabling further testing and refinement of operational procedures for the Future ATM/ANS programme.

A6 **Automated ATM/UTM Approvals**: New ATM/UTM solutions shall enable automated or simplified flight approvals in defined operational environments using advanced technologies and updated procedures, leading to new UAS services.

A7 **Interim IFR/VFR Equivalence**: The technical airspace architecture shall allow UAS to operate under IFR or VFR-equivalent conditions through technical means as an interim solution. Certified category UAS shall initially operate under IFR or VFR rules.

A8 **Regulatory Exemptions for Specific Category UAS**: Specific category UAS shall be exempt from certain SERA regulations via UK Regulation 2019/947 on rules and procedures for the operation of unmanned aircraft, ensuring only relevant IFR/VFR requirements apply.

A9 **Operations Without Radio Communication**: UAS operations without radiocommunication shall be permitted within TRA airspace, provided alternative communication services are agreed upon between the ANSP and the UAS operator.

A10 **ICAO Airspace Compliance**: The airspace shall maintain compliance with ICAO classification standards while enabling the integration of new operational concepts.

A11 **TLOS and Risk Characterisation**: Integrated operations shall be supported by clearly defined TLOS requirements and airspace risk characterisation. These shall align with the UK CAA DAA policy and apply to all four operational concepts.

A12 **Ongoing Safety Oversight**: The UK CAA shall conduct continuous safety oversight of air risk, including audits, to ensure it remains within the initially assessed limits.

Key UTM Requirements

Interoperability with ATM & EU U-Space: UTM should seek appropriate interoperability with existing ATM technologies and infrastructure, supporting a combined system that maintains continuity and efficiency. It should also consider interoperability with overseas operators wishing to operate in the UK. Looking ahead, recognition of and potential alignment with international (e.g. EASA U-Space) work may be required to support wider harmonisation.

A13 **Phased UTM Implementation & Initial Focus Areas:** UTM deployment shall initially be limited to UAS operations, with implementation beginning in areas with existing UAS traffic and regions with existing demand. Over time, the system will gradually expand to cover broader areas while maintaining a strategic approach to phased development.

A14 **Integration with Existing Regulatory & Operational Frameworks:** UTM implementation[53] shall align with existing AMS objectives, aviation regulations, guidance material, and acceptable means of compliance. Early-stage adoption will address regulatory gaps, particularly in areas such as flight planning, while ensuring industry and airspace user cooperation.

[53] UK UTM ConOps 2025 – Chapter 3 UTM Implementation and Next Steps

A15 **UTM Services & Standardisation:** The suite of UTM services[54] shall be based on ICAO recommendations, ensuring consistent service parameters and uniform implementation across the UK. FUA principle shall be incorporated into UTM operations to dynamically accommodate various aerial activities without excessive airspace reservations.

A16 **Infrastructure, Digitalisation & Data Exchange**: In the early phases, UTM services shall be integrated with existing ANSPs to identify limitations and demonstrate the need for a digital system. The system shall establish assured communication networks based on SWIM standards, ensuring safe data exchange between manned and unmanned aircraft while addressing the General Data Protection Regulation (GDPR) and cyber security concerns.

A17 **Safety & Risk Management:** UTM should incorporate an appropriate safety management process and ensure incident and accident investigation frameworks are adapted to address risks specific to unmanned operations. The extent of safety management required will be determined through certification under Part 373, up to and including a formal Safety Management System where appropriate. Temporary tools such as TRAs and TMZs will be used for trial development, supporting the safe integration of UTM services.

Key DAA Requirements

A18 **Safe BVLOS Integration**: DAA capabilities shall enable BVLOS UAS operations while ensuring safe integration with manned aircraft and compliance with ATM and ATC procedures.

A19 **Operational Trials**: DAA systems shall be rigorously tested in real-world trials to assess detection accuracy, collision-avoidance effectiveness and response times in various environments.

A20 **Cooperative Surveillance**: To enhance situational awareness and improve conflict resolution, a collaborative data-sharing system between ATC, UTM, and airborne surveillance platforms shall be established.

A21 **Risk-Based Implementation**: DAA shall be designed according to a risk-based approach, aligning with SORA and ARC classifications, ensuring that airspace complexity dictates the level of DAA capability required.

A22 **Ground-Based Detection Networks**: ADS-B, MLAT, and RF-based tracking systems shall support EC and offboard DAA functionality, enhancing UAS separation assurance.

[54] Technical requirements for UK Unmanned aircraft systems Traffic Management (UTM) Services – Policy Concept Version 1.0 – 6. Technical Requirements of Specific UTM Services

A23 **Regulatory Compliance**: The UK CAA shall review and approve all DAA operational requirements, ensuring alignment with national and international aviation safety standards.

Key C2 Link Requirements

A24 **Standardised Requirements**: C2 Link performance requirements shall align with ICAO Annex 6 Part 4 and Annex 10 proportionately and as appropriate, ensuring reliability, redundancy, and alignment with global aviation and telecommunication standards.

A25 **Risk-Based Assessment**: BVLOS C2 operations shall undergo structured risk evaluations based on UK SORA methodology to mitigate link integrity risks, including interference and cyber security threats.

A26 **Backup Communication Methods**: Secondary C2 Link, if required by the operation, in case of primary C2 failure. Other contingency options to notify ATC in Controlled Airspace about the failure, such as VHF voice or mobile phone, may also be considered.

A27 **Assurance of Network Integrity**: Authorised service providers shall be permitted to guarantee C2 network integrity, prohibiting resellers from defining performance to maintain security and long-term reliability. Alternatively, network data integrity and protection can be provided by using a secure connection, such as IPSec, with appropriate authentication.

A28 **BVLOS Authorisation Framework**: Risk-based methodologies such as SORA shall guide the approval process for BVLOS-specific category operations, ensuring appropriate safety measures and any additional measures are in place.

A29 GI shall be developed to specifically support BVLOS flights, ensuring low-latency and high-reliability communication networks for extended-range UAS missions.

Key GI Requirements

A30 **Support for EC and C2 Resilience:** GI shall enhance EC reliability by supporting MLAT functions and supporting the C2 infrastructure, for the purpose of serving as a backup (dedicated critical C2 infrastructure) and/or enhancing usability of low power EC devices, e.g. using TIS-B.

A31 **Airspace Users unable to equip with EC**: GI shall support airspace users that are unable to equip with EC devices.

Key EC Requirements

A32 **Integration with DAA**: EC shall be a fundamental enabler of DAA for autonomous UAS; however, additional safety technologies shall be required to meet comprehensive DAA performance standards. It is noted that EC may not be the only fundamental enabler of DAA capability.

A33 **Airspace-Specific Implementation**: EC functions shall be tailored based on airspace classification, operational risk levels, and flight complexity, ensuring regulatory compliance.

A34 **Operationally Aligned Technologies**: EC solutions[55] shall be chosen based on operational needs, incorporating ADS-B, MLAT, and RF-based tracking systems for situational awareness and conflict management, in line with GI implementation.

A35 **Mandatory Equipage Compliance**: UAS operating within a given airspace must comply with the EC equipage standards mandated for that airspace.

A36 **Lower-Level Airspace Safety Standards**: A structured lower-level airspace concept, aligned with ICAO frameworks, shall be developed to ensure a defined TLOS for safe UAS integration.

Notes

A37 Additional specifications and detailed requirements, as well as operational concepts for several elements of the Future ATM & ANS framework, are defined in the specific ConOps and policy concepts for EC, DAA, GI, C2 Link, and UTM.

[55] Electronic Conspicuity UK EC Airspace Architecture Work Stream 4 Report – 3.1 EC Functional Overview

APPENDIX B

Mitigation Table

Table 1 - UK CAA Future ATM/ANS ConOps

Scenario	Initial Arc → Residual ARC	Strategic Mitigation	Tactical Mitigation
A0	ARC-a → ARC-a	SM1 – Operational restriction by boundary (≤50 ft from linear infrastructure, or ≤100 ft of any building or structure) SM8 – NOTAM / AIC of intended operation	TM3 – transmitting on 978 MHz and receiving on dual frequencies 978 MHz and 1090 MHz TM5 – Monitoring of local cooperative traffic
A1	ARC-a → ARC-a	SM1 – Operational restriction by boundary SM7 – Pre-agreement of UTM services (strategic deconfliction, where available) SM8 – NOTAM / AIC	TM3 – transmitting on 978 MHz and receiving on dual frequencies 978 MHz and 1090 MHz TM5 – Monitoring of local cooperative traffic
LL0	ARC-c → ARC-a/b	SM4 – Special Use Airspace (TRA/TDA) SM5 – TMZ (cooperative EC environment) SM6 – Pre-agreed ANSP services (TRA/TDA management) (Optional) SM7 – Basic UTM services	TM2 – DAA (information-only, ground-based) TM3 – Carriage of EC Out TM5 – Monitoring of local cooperative traffic
LL1	ARC-b → ARC-b	SM5 – TMZ SM6 – Pre-agreed ANSP services SM7 – Pre-agreed UTM services (flight authorisation, strategic deconfliction)	TM2 – DAA (approved to ARC-b) TM3 – Carriage of EC Out TM5 – Monitoring of local cooperative traffic

Scenario	Initial Arc → Residual ARC	Strategic Mitigation	Tactical Mitigation
LL2	ARC-c → ARC-c	SM5 – TMZ (permanent cooperative EC environment) SM7 – Pre-agreed UTM services (strategic + tactical, traffic density-dependent)	TM2 – DAA (approved to ARC-c, automated) TM3 – Carriage of EC Out TM5 – Monitoring of local cooperative traffic
FI0	ARC-c → ARC-a	SM4 – Special Use Airspace (TDA)	(Optional) TM3 – Carriage of EC Out (Optional) TM5 – Monitoring of local traffic
FI1	ARC-c → ARC-b	SM4 – Special Use Airspace (TRA or permanent) SM5 – TMZ SM6 – Pre-agreed ANSP coordination (Optional) SM7 – Basic UTM services	TM2 – DAA (information-only, residual ARC-b) TM3 – Carriage of EC Out TM5 – Monitoring of local cooperative traffic
FI2	ARC-b → ARC-b	SM5 – TMZ SM7 – Pre-agreed UTM services (UA-to-manned strategic separation service in coordination with ATM)	TM3 – Carriage of EC Out TM5 – Monitoring of local traffic DAA replaced by UTM-provided separation
FI3	ARC-d / ARC-c → ARC-c	SM5 – TMZ SM7 – Pre-agreed UTM services (strategic + tactical) SM1 – Operational restriction by boundary (route-based)	TM2 – DAA (approved to ARC-c, multi-sensor) TM3 – Carriage of EC Out TM5 – Monitoring of local cooperative traffic

APPENDIX C

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