

Innovation Hub
**A Unified Approach
to the Introduction of
UAS Traffic Management**

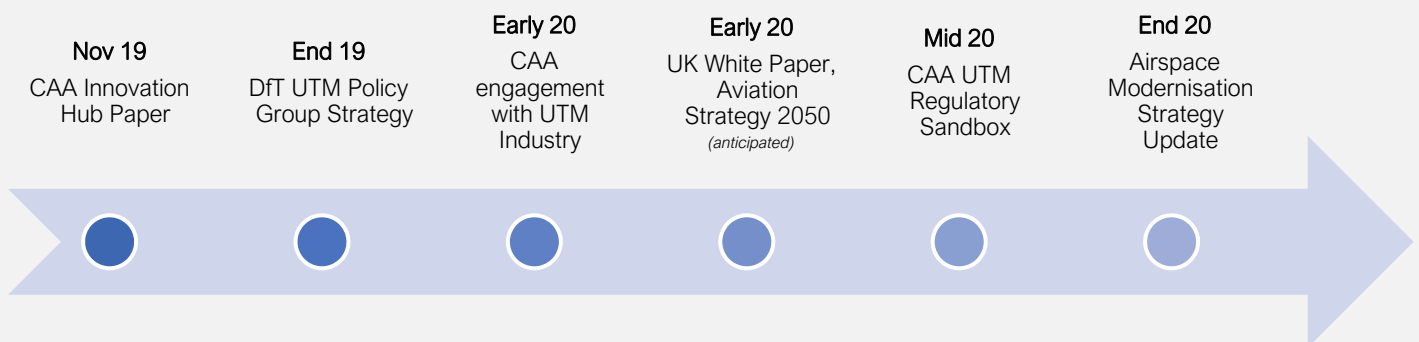
Introduction

The intention of this Innovation Hub paper is to recommend actions to create a policy framework that will facilitate the introduction of a unified approach to the safe integration of unmanned aircraft systems (UAS).

The paper also aims to give an appreciation of the scale and breadth of impact that the integration of UAS into UK airspace could have across the aviation ecosystem. This aims to justify why the development and implementation of policies, regulations, technology and systems will require extensive collaboration and leadership on a national and international scale.

The recommendations are summarised on page 29 and are aimed primarily at the CAA and HM Government to facilitate positive action in the near term. Publishing these recommendations is intended to aid transparency on the process and progress of the CAA in this area.

It is expected that the paper will inform the government's Aviation Strategy 2050 via the joint UTM Policy Group, which may also take forward some of the actions. Necessary enabling work, once it is defined, will be included in an updated Airspace Modernisation Strategy to help deliver UAS traffic management (UTM) in coordination with the other initiatives to modernise the UK's airspace.



What is UTM?

The potential uses, benefits and risks of UAS are such that there is a global race to enable their safe integration into our lives. Currently there is insufficient infrastructure in place to fully enable and safely manage the widespread use of unmanned aircraft in the UK. While projections of the number of unmanned aircraft operating in future vary, they generally agree that the numbers are increasing dramatically and so will need to be managed in some way.

Definitions

The concept of 'UAS traffic management' was popularised by NASA who researched prototype technologies that could develop airspace integration requirements for enabling safe, efficient low-altitude operations¹.

ICAO defines UAS traffic management as

"a specific aspect of air traffic management which manages UAS operations safely, economically and efficiently through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions."

In Europe, an equivalent concept was named 'U-Space'. This represents a set of procedures and services that enable safe integration of unmanned aircraft into the airspace. The objectives outlined in the U-Space Blueprint² represent a vision which is shared by others including the CAA: creating a new airspace environment that accommodates new technology in a way that is sustainable, flexible and scalable.

Like NASA's UTM, U-Space also considers the interaction between the so-called 'very low level' airspace, typically below 500ft, and traditional air traffic operating above 500ft³.



The Connected Places Catapult (CPC)⁴ are leading UAS traffic management work through 2019-20 to build on previous work to develop a UK framework based on open access principles, with support from the Department for Transport (DfT), CAA, a consortium of industry specialists and broader consultation. This work recommends an architecture for UAS traffic management that includes several key roles:

- **Central Services** offering vital services to the UAS traffic management ecosystem including a flight information and management system, the authorisation and directory of UAS traffic management Service Providers, a flight notice board, and UAS and operator registration.
- **UAS traffic management Service Providers**, offering specific UTM services to the public, businesses, local authorities, and others.
- **Supplementary Data Service Providers** who provide the data that supports the functioning of the UAS traffic management ecosystem, including weather, terrain and obstacle data along with insurance and surveillance data.
- **Air Traffic Service Providers** who will need to interact in some way with the unmanned traffic system.
- **Public Authorities**, who may in future be required to engage in the ecosystem as an authority holder for certain operations.

¹ <https://utm.arc.nasa.gov/index.shtml>

² <https://www.sesarju.eu/sites/default/files/documents/reports/U-space%20Blueprint%20brochure%20final.PDF>

³ The Ministry of Defence routinely operates below 500ft in the UK.

⁴ The Connected Places Catapult (<https://cp.catapult.org.uk/>) are one of 9 'catapult' organisations which are funded by Innovate UK (Department for Business, Energy and Industrial Strategy) to accelerate technology uptake and integration across different sectors in the UK.

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- **The regulator (CAA)**, with the ability to licence, certify and conduct oversight of those operating within the ecosystem.

Some explanation of the types of 'services' that could form part of this ecosystem are given later.

The Benefits of UAS traffic management

There are many articulations of how UAS traffic management can bring benefits across society, but the Single European Sky ATM Research Joint Undertaking (SESAR-JU) work below describes it well:

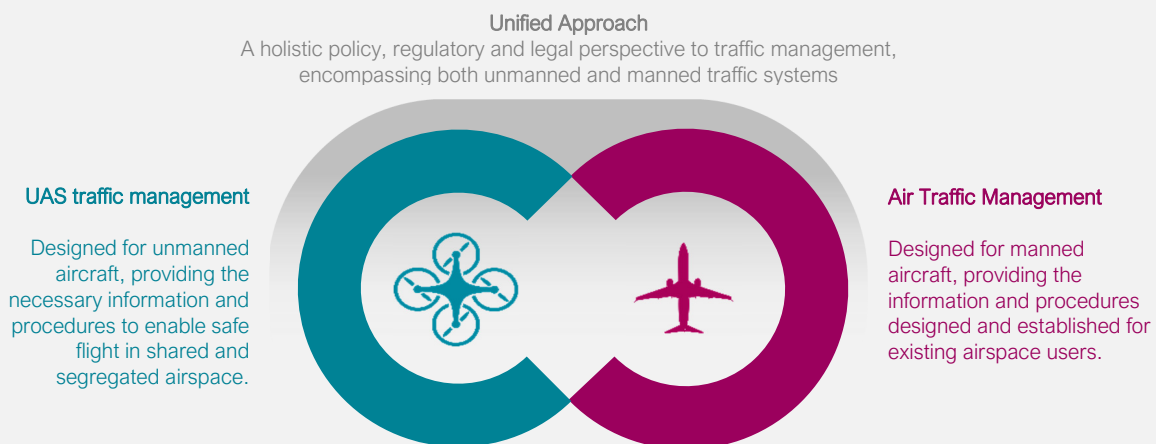
The U-Space Blueprint also describes a number of 'principles' which help to describe the purpose of UAS traffic management as well as an indication of its benefits:

- Enable **safety for all users** of the U-Space framework, as well as those on the ground.
- Enable a **scalable, flexible framework** that adapts to technology and demand, while managing the interface with manned aviation.
- To enable **high-density operations** with multiple automated drones under the supervision of fleet operators.
- To guarantee **equitable and fair access** to airspace for all users.
- To enable **competitive and cost-effective** service provision at all times, supporting the business models of drone operators
- To **minimise deployment and operating costs** by leveraging existing technology and infrastructure.
- To **accelerate deployment** by adopting technologies and standards from other sectors
- To follow a **risk-based and performance-driven approach** when setting up appropriate requirements for safety, security and resilience, while minimising environmental impact and respecting privacy.

The CAA recognises the synergies across these initiatives and believes that taking a unified approach to the safe integration of UAS into UK airspace will involve elements from all of these.

A 'Unified' Approach

Air Traffic Management (ATM) enables the safe and efficient movement of aircraft through the air and on the ground. It includes many different but connected systems that work together to achieve this. It also requires a significant amount of human input and control.



It is sensible to assume that unmanned air traffic will need to be managed in the future for the same purpose. As such, if manned and unmanned air traffic continue to be managed separately into the future this will limit the safety and economic performance and efficiency that can be achieved, so a unified approach is required.

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In addition, there are several features of any potential UAS traffic management services which could feasibly benefit manned traffic as well, either directly (e.g. a service developed for unmanned aircraft which could be used directly by manned aircraft) or indirectly (e.g. the reduction in the risk of mid-air collision between an unmanned and a manned aircraft). As such, we must be cognisant of the increasing overlap between the manned and unmanned.

The Scope of UAS Traffic Management Services

There is already a growing market of services around the world aiming to provide elements of an ecosystem that manages unmanned aircraft, with significant work being done to try and define a standard set of services and procedures as well as the regulatory frameworks necessary.

The on-board technology of future UAS, such as 'detect and avoid', will go some way to increasing the scope and capability of some unmanned operations by enabling flight beyond visual line of sight for example. However, an UAS traffic management system is expected to unlock the scale of safe integration, with the resultant increase in regular commercial operations and the economic and societal benefits which that brings.

A roadmap to this vision can take different paths since many of the building blocks could reasonably operate and add value in isolation (see 'Building Blocks' below).

The generic concept of operations for UAS traffic management tends to include several services and functionalities. The non-exhaustive list of functions below helps to explain what constitutes an ecosystem that manages unmanned traffic:

Phase of Operation	UTM Service	Description
Approvals & Licencing	UAS Traffic Management Services	Formal approval or endorsement of UAS traffic management services against a specific regulatory framework.
	Operators, Remote Pilots & Aircraft	Encompassing training, approval, registration, insurance and more
	Data	Approval and oversight of the fundamental data necessary for UAS traffic management services.
Flight Planning	Flight planning	calculating a safe and efficient route, accounting for air and ground risks
	Flight notification or declaration	publication of a flight plan in such a way that other flight planning services can carry out their own flight plan ("strategic") deconfliction.
	Airspace authorisations	allowing specific authorities, such as an air navigation service provider (ANSP), to authorise access to controlled or otherwise managed airspace.
	Flight plan deconfliction	to minimise loss of separation and the risk of mid-air collision with other manned and unmanned aircraft, based on other flight plans. Sometimes referred to as 'strategic' or 'pre-tactical' ⁵ deconfliction

⁵ 'Pre-tactical' is used by U-Space.

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Pre-Flight	Pre-flight checks	supporting the remote pilot to complete pre-flight checklists, or in some cases carrying them out on behalf of the remote pilot.
	Pre-flight authorisations	confirming the approved flight plan before take-off, and as required by certain procedures or geographical locations.
	Approval to take-off	including the coordination with ATM where necessary
During Flight	Sharing of real-time flight information	position ⁶ , speed, heading are shared from the aircraft to air traffic service providers, local and enforcement authorities, government, other aircraft (manned and unmanned), etc
	In-flight deconfliction	real-time commands are given to pilots or aircraft directly to mitigate loss of separation or a mid-air collision between both manned and unmanned aircraft. Often referred to as “tactical” deconfliction.
	Dynamic airspace restrictions	enabling immediate segregation or notification of airspace for specific purposes (e.g. enforcement authorities clearing airspace over an incident, or in support of counter-terrorism operations)
	Re-planning and re-routing of unmanned traffic	enabling immediate segregation or notification of airspace for specific purposes (e.g. enforcement authorities clearing airspace over an incident, or in support of counter-terrorism operations)
	Re-planning and re-routing of unmanned traffic	in response to a change in the airspace picture or change in mission.
	Urgency or Emergency Response	Management of other air traffic in response to an aircraft urgency or emergency
Post-Flight	Flight review & recording	for audit, statistics and traceability
	Oversight	Regulatory monitoring and review of unmanned aircraft activity

With regards to services that deconflict aircraft trajectories either at the flight planning stage, or during flight, there is currently no harmonised position on how aircraft should be prioritised. While deconfliction will likely consider the ICAO prioritisation described in CAP 493 Manual of Air Traffic Services⁷, this does not specifically account for unmanned aircraft. Therefore, there is currently uncertainty of the prioritisation of manned vs unmanned, and unmanned vs unmanned (for example): manned life-saving vs unmanned life-saving; unmanned people-carrying vs unmanned cargo-carrying; etc. There may be assumptions as to how these are dealt with, but this is not yet formalised.

⁶ Position in time and space

⁷ CAP 493 Manual of Air Traffic Services⁷ Part 1, Section 1, Chapter 4, Control of Traffic, Page 6, [https://publicapps.caa.co.uk/docs/33/CAP493_28DEC2017\(P\).pdf#page=84](https://publicapps.caa.co.uk/docs/33/CAP493_28DEC2017(P).pdf#page=84)

What is UTM?

In addition, the extent of unmanned aircraft and other new airspace users below 400ft is unknown. If traffic intensifies and certain flight plans start to become prevalent, a broader approach might be needed, similar to that in controlled airspace whereby routes are designed through evidence and public consultation. There may then need to be a mechanism in future for monitoring whether any paths or plans become prevalent, and whether they are having an impact on other airspace users and people on the ground. An UAS traffic management system could potentially offer or support this functionality.

Recommendation 1

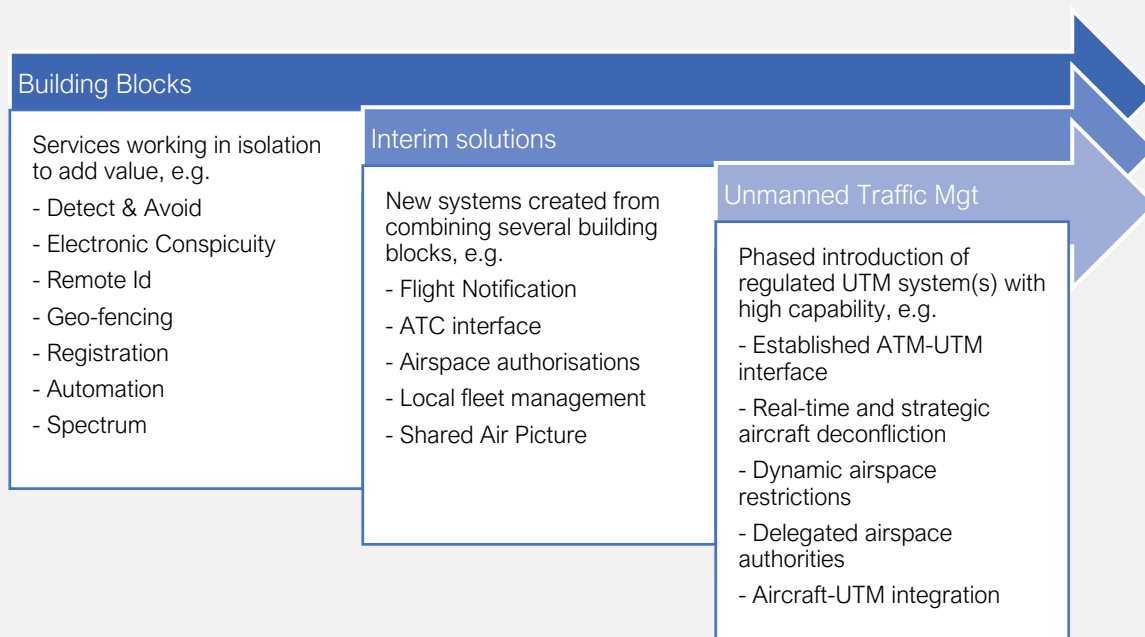
The ICAO flight priorities should be assessed in the context of airspace that is shared by all airspace users, taking account of both the category of aircraft and its operational purpose.

Building Blocks of UAS Traffic Management

While there are indications that ATM is transitioning away from routine interventions by Air Traffic Controllers (ATCO) towards predominantly 'monitoring' functions⁸, UAS traffic management systems are expected to be designed from the start with automation in mind (with a minimal requirement for human-in-the-loop) driven by the high volume of aircraft expected to rely on it.

Recommendation 2

Existing roadmaps showing the progression of UAS traffic management should be assessed and either recognised by the CAA or used to generate a CAA roadmap.



Illustrative roadmap for the development and integration of UAS traffic management

Several components, systems and policies are expected to contribute to UAS traffic management. The full extent is still to be established, and is dependent on the system architecture that is taken forward, but is likely to include:

- Static and dynamic airspace information, structures (e.g. Control Zones, Control Areas) and restrictions (Prohibited/Restricted/Danger Areas)
- Aeronautical information
- Airspace classifications

⁸ For example, the NATS Airspace User Portal (AUP) provides general aviation and remote pilots with a way to request access to controlled airspace via an online service or a smartphone app. For the airspace controller it also provides a way to set rules for automatic decline / approval of requests and an interface that can be used to see outstanding requests. <https://aup.nats.aero/>

What is UTM?

- Electronic conspicuity
- Geographical information (e.g. terrain)
- Obstacle information (e.g. buildings)
- Operator registration
- Unmanned aircraft registration⁹
- Meteorological information
- Communications, Navigation and Surveillance (CNS) and Spectrum
- Airspace regulation & delegated powers or authority

To ensure that the resultant ecosystem is open and transparent, and to achieve flexibility, scalability and sustainability, all the above will need to be underpinned by agreed standards, protocols and procedures.

Stakeholders

The number of stakeholders who could potentially interact with an UAS traffic management system is extensive. Below is an indication of the variety of involved stakeholders:

- UAS Remote Pilots
- UAS Operators
- Manned aircraft pilots
- Manned aircraft operators
- UAS traffic management Service Providers
- ANSP / ATC / other ATM Service Providers
- Equipment manufacturers
- Aerodrome operators
- Emergency services
- Enforcement authorities
- Public & Local authorities
- Government
- Military¹⁰
- Meteorological and aeronautical information service providers
- CAA & other regulators
- Overflown communities
- Non-Government Organisations, campaign groups etc
- Passengers (on manned or unmanned)
- Shippers (on manned or unmanned)
- Consumers of the goods shipped
- Academics

⁹ Including the record of aircraft performance and/or equipage

¹⁰ Noting that this encompasses many of the functions listed above but in a military context.



There are existing laws, policies and regulatory guidance across UK Government and the CAA that have an impact on the unified approach to air traffic management at a strategic, programme and component level. There are also numerous initiatives seeking to facilitate a safe and efficient use of airspace into the future. To achieve positive progress on this approach for the UK a recognition of this context is necessary.

Where the existing legal and regulatory context may prove problematic for UAS traffic management, recommendations will be developed to consider how to maintain progress such as, for example, changing or introducing policy, or interpreting policy for new requirements.

The Legal and Regulatory Context

The CAA's Legal Duties

The CAA is tasked with various functions by the Secretary of State for Transport through powers defined in Section 66 of the Transport Act 2000 (as amended). These legal functions of the CAA are described in the Civil Aviation Authority (Air Navigation) Directions 2017 (as amended). Section 70 of the Transport Act describes the approach the CAA should take when exercising its air navigation functions. This establishes that maintaining a high standard of safety should be prioritised and outlines seven further considerations including the need to:

- a) to secure the most efficient use of airspace consistent with the safe operation of aircraft and the expeditious flow of air traffic;
- b) to satisfy the requirements of operators and owners of all classes of aircraft;
- c) to take account of the interests of any person (other than an operator or owner of an aircraft) in relation to the use of any particular airspace or the use of airspace generally;
- d) to take account of any guidance on environmental objectives given to the CAA by the Secretary of State after the coming into force of this section;
- e) to facilitate the integrated operation of air traffic services provided by or on behalf of the armed forces of the Crown and other air traffic services;
- f) to take account of the interests of national security;
- g) to take account of any international obligations of the United Kingdom notified to the CAA by the Secretary of State (whatever the time or purpose of the notification).

Under the Directions it is the CAA's function to have a strategy and plan for the use of UK airspace (Direction 3(e)), and to make decisions that determine the design of UK airspace (direction 5). The 'design' of airspace includes both the physical structures as well as the procedures applied within it.

Subject to our primary duty to maintain a high standard of safety, the CAA's Section 70 duties include an obligation to "satisfy the requirements of operators and owners of all classes of aircraft". The CAA is therefore required to consider the needs and requirements of unmanned aircraft users in its strategy when exercising its air navigation functions.

Airspace Design

Airspace design includes blocks of controlled airspace with varying classifications of A, C, D or E and the classification determines the behaviours and equipage requirements, set by provisions in the Air Navigation Order 2016 (as amended) (ANO), for aircraft entering the airspace. Class G represents uncontrolled airspace.