



## Five Critical Enablers for Safe, Efficient, and Viable UAS Traffic Management (UTM)

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# CONTENTS

1	INTRODUCTION .....	4
2	WHAT IS UTM?.....	4
3	WHY UTM? .....	7
4	THE AIRMAP UTM PLATFORM .....	8
5	REGISTRY ENGINE .....	8
6	GEO ENGINE.....	9
7	FLIGHT ENGINE .....	10
8	TRAFFIC ENGINE.....	10
9	USER INTERFACES .....	11
10	COMPATIBILITY .....	11
11	SUMMARY .....	12

## Introduction

In the past four years, forecasts have predicted soaring market valuations for the unmanned aircraft industry.<sup>1</sup> Already, unmanned aircraft, or drones, are transforming everyday work with proven applications for crop dusting, photogrammetry, inspection, construction, public safety, and more.

Yet, actual numbers for drone adoption worldwide reflect known challenges with safe, efficient, and viable integration into existing airspace systems.<sup>2</sup>

Safety is of top importance among Air Navigation Services Providers (ANSPs) and Civil Aviation Authorities (CAAs), who have long maintained a legacy of airspace security with the highest standards for safety, vigilance, and customer service. Integrating drones into a cooperative airspace system requires maintaining these standards with tools to educate and inform remote pilots about situational awareness, safety standards, and aviation protocol.

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*There is a clear path from ATM to an integrated and cooperative airspace system with UTM.*

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Efficiency is also critical to effective integration. One of the top benefits of drones is the ability to deploy them more quickly, cheaply, and safely than manned aircraft.<sup>3</sup> Unlike manned aircraft, drones can be up and running in a matter of minutes, completing dozens of missions each day. This fast-acting technology requires a fast-acting airspace management system that integrates seamlessly into existing ATM systems without hindering the drone industry.

Finally, an integrated and cooperative airspace management system for all aircraft must be technologically and financially viable long-term. ANSPs and CAAs worldwide need an intelligent and adaptive system that is established, future-proof, and profitable for a wide variety of drone operations across all airspace environments.

There is a clear path from Air Traffic Management (ATM) to an integrated and cooperative airspace system with Unmanned aerial systems (UAS) Traffic Management (UTM).

This whitepaper discusses models for UTM and defines the critical drivers for a safe, efficient, and viable integrated airspace system, all of which are available through the AirMap UTM platform, designed and deployed in partnership with ANSPs, CAAs, and the drone industry.

## What is UTM?

UAS Traffic Management is "a system of stakeholders and technical systems collaborating in certain interactions, and according to certain regulations, to maintain safe separation of unmanned aircraft, between themselves and from ATM users, at very low level, and to provide an efficient and orderly flow of traffic," according to the Global UTM Association, or GUTMA.<sup>4</sup>

Regulators, airspace managers, and private industry partners like AirMap have collaborated extensively over the past three years in researching, building, testing, and harmonizing the technical systems needed

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<sup>1</sup> <http://www.unmannedairspace.info/uav-traffic-management-services>

<sup>2</sup> <http://droneanalyst.com/research/research-studies/2017-drone-market-sector-report>

<sup>3</sup> <https://www.pwc.pl/pl/pdf/clarity-from-above-pwc.pdf>

<sup>4</sup> [https://www.gutma.org/docs/Global\\_UTM\\_Architecture\\_V1.pdf](https://www.gutma.org/docs/Global_UTM_Architecture_V1.pdf)

# UTM Research Technical Capability Level



Each capability is targeted to type of application, geographical area and uses risk-based approach

## CAPABILITY 1

- Reservation of airspace volume
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot
- Enable agriculture, firefighting, infrastructure monitoring

## CAPABILITY 3

- Beyond visual line of sight
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected
- Public safety, limited package delivery

## CAPABILITY 2

- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

## CAPABILITY 4

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use

*NASA-UTM diagram courtesy of [utm.arc.nasa.gov](http://utm.arc.nasa.gov)*

to realize UTM at a global scale. The result is two leading frameworks for UTM systems and capabilities: NASA-UTM and U-space.

## NASA-UTM

Developed by NASA and the FAA, NASA-UTM is a collaborative research project with the goal of developing and demonstrating a possible UTM system that can safely enable drone operations in low-altitude airspace.<sup>5</sup> It is defined in terms of four distinct Technology Capability Levels (TCL) to be researched, tested, and refined over the course of four years.

In late 2015, NASA-UTM demonstrated TCL1 capabilities, which addressed operations for agriculture, firefighting, and infrastructure monitoring, with a focus on geofencing, rule-based situational awareness, and flight planning.

Tested in October 2016, TCL 2 focused on beyond visual line-of-sight (BVLOS) operations in sparsely populated areas, including adjusting flight plans to changes in dynamic airspace conditions and contingency management.

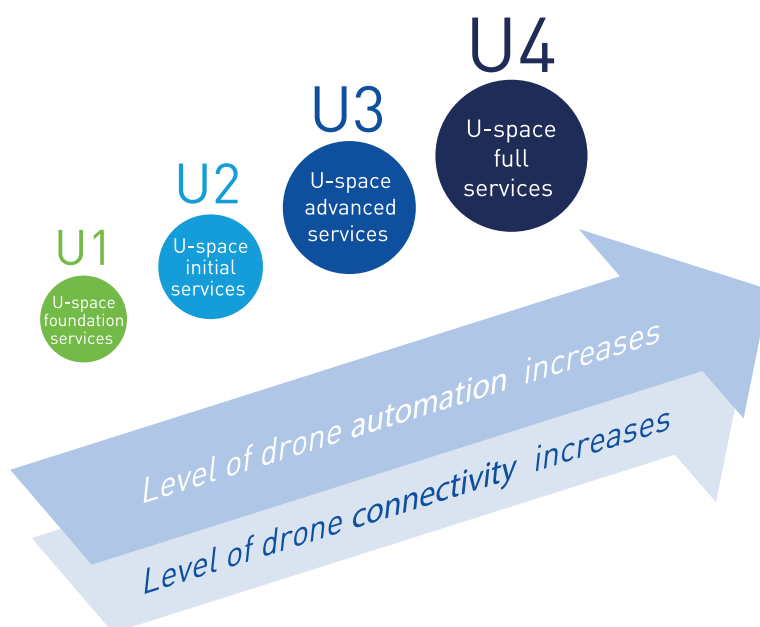
This spring, TCL3 will test technologies that maintain safe spacing between cooperative and non-cooperative drones over more populated areas. And TCL4, with test dates to be determined, will focus on drone operations in densely populated urban areas for highly anticipated drone applications like news coverage and package delivery. TCL4 will also test technologies that could be used to manage large-scale contingencies.

<sup>5</sup> <https://utm.arc.nasa.gov/index.shtml>

AirMap is a key collaborator and UAS Service Supplier (USS) in ongoing NASA-UTM trials, having demonstrated TCL 1 and TCL 2 capabilities at test sites across the United States, with TCL 3 testing scheduled for spring 2018.

## U-space

Defined by SESAR JU, the Single European Sky ATM Research Joint Undertaking, U-space is a set of UTM services and procedures designed to support safe, efficient, and secure access to airspace for drones.<sup>6</sup> U-space services rely on a high degree of automation and digitalization to ensure the smooth operation of all categories of drones on all types of missions in all operating environments. Much like the NASA-UTM initiative, U-space is a collaborative effort among industry and regulators to enable situational awareness, data exchange, and digital communication with the drone ecosystem as well as manned aviation, ATM service providers, and authorities. U-space is defined in terms of four distinct U-levels, outlined in the diagram below.



*U-space diagram courtesy of SESAR JU*

U-space differs from classical ATM in that it is digital and predominantly self-managed, relying primarily on automation and autonomous capabilities, with drones themselves performing many of the U-space services, including deconfliction. U-space involves minimal human interaction, giving rise to a variety of business models that vary from traditional ATM both economically and financially.

On September 14, 2017, AirMap provided UTM services in the first live demonstration of U-space U1 and U2 capabilities.<sup>7</sup> With skyguide, SITAONAIR, senseFly, Intel, and PX4, AirMap provided integrated geofencing,

<sup>6</sup> <https://www.sesarju.eu/u-space-blueprint>

<sup>7</sup> <https://www.skyguide.ch/en/events-media-board/u-space-live-demonstration>

flight planning, airspace authorization, live telemetry, and deconfliction services in the densely populated urban environment of Geneva, Switzerland, close to the second busiest airport in Switzerland.<sup>8</sup>

	<b>NASA-UTM</b>	<b>U-space</b>
<b>Phase 1</b>	Geofencing, Altitude “rules of the road” & scheduling of vehicle trajectories.	E-registration, E-identification, Geofencing
<b>Phase 2</b>	Beyond visual line-of-sight operations in sparsely populated areas. Dynamic adjustments to availability of airspace and contingency management.	Flight planning, Flight approval, Tracking, Dynamic airspace information & geofencing, Procedural interfaces with ATC
<b>Phase 3</b>	Safe spacing between cooperative (responsive) and non-cooperative (non-responsive) UAS over moderately populated areas.	Capacity management, Autonomous deconfliction
<b>Phase 4</b>	UAS operations in higher-density urban areas for tasks such as news gathering and package delivery. It will also test technologies that could be used to manage large-scale contingencies.	Integrated interfaces with manned aviation, Automation, Connectivity, Digitization

While NASA-UTM and U-space vary slightly their services outlined and timelines proposed, both frameworks position UTM services to increase in complexity over time, with more advanced services emerging to enable complex operations, such as package delivery in densely populated environments.

## Why UTM?

UAS Traffic Management is the best model for safe, efficient, and viable integrated airspace because it makes use of connected and scalable systems that are already available today.

Throughout the world, smartphone technology connects people and systems over existing mobile network infrastructure (2G, 3G, 4G/LTE, and soon 5G). Moreover, findings from the mobile phone and automotive industries have demonstrated that internet technology can be adopted easily and rapidly where there is connectivity.

Many drones are already connected to the internet, while others connect to internet-powered Ground

<sup>8</sup> <http://www.bfs.admin.ch/bfs/portal/en/index/news/publikationen.html?publicationID=6728>

Control Station (GCS) software. By delivering services over internet-enabled technologies, UTM fits seamlessly into existing digital infrastructure and matches the pace set by internet-enabled drone technology, without any burden to drone operators or manufacturers.

On the rare occasions in which a flight area lacks network coverage, operators can plan flights, send notice, and/or request digital authorizations in advance from a connected region.

Hardware-based solutions are possible, but should be implemented on open and standardized protocols to promote fair market mechanics.

By leveraging existing digital technologies on an open, agnostic, and connected platform, UTM is scalable. With AirMap UTM, AirMap has demonstrated in trials and deployments around the world that UTM is ready for global adoption and scalable for any airspace, regulatory landscape, and operating environment with a high volume of flights.

## The AirMap UTM Platform

As part our work on NASA-UTM and U-space, as well as our engagements in Switzerland, New Zealand, Japan, and the United States, AirMap has developed AirMap UTM, a platform of airspace services built to meet the needs of the drone industry today and in the future.<sup>9</sup> From our extensive research and development worldwide, we've identified five foundational enablers for UTM and have made them available to the drone industry on the AirMap UTM platform. They are:

- **Registry Engine** with e-registration and e-identification for drones and pilots,
- **Geo Engine** to manage airspace and rules, the foundation of any information system for operators or autonomous drones,
- **Flight Engine** with automated and manual notification, authorization, and 2-way communication capabilities between airspace managers and drone operators,
- **Traffic Engine** with real-time manned and unmanned positioning information, and
- **User Interfaces** that establish 2-way communication between airspace managers with drone operators on an open and hardware-agnostic platform

These critical enablers and their capabilities are outlined below.

### Registry Engine

Proper registry and identification mechanisms allow authorities to monitor flight activity and identify drones in-flight for safety and security. It is necessary to provide both a level of trust in the identification of a drone and/or a pilot, as well as a way to identify accountable persons or entities in cases of legal infringements.

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<sup>9</sup> [www.airmap.com/utm](http://www.airmap.com/utm)

During the U-space demonstration in Geneva, AirMap demonstrated an easy and integrated solution for e-registration, e-identification, and identity authentication for a third party registry. In a matter of seconds, AirMap called, matched, and verified the drone operator's public registration status against the existing pilot registry website and database provided.

Moreover, when a remote pilot creates an AirMap account via the AirMap user interface, account details can populate any registry database with pilot and aircraft details. Thus, the AirMap Registry Engine can stand alone or integrate seamlessly with existing pilot and drone registry databases from CAAS, while ensuring that privacy regulations and requirements are met.

## Geo Engine

What makes drones most unique from other aircraft is the airspace in which they operate. At low altitudes, drone operators must be aware of advisories pertaining to parks, critical infrastructure, emergency responder activities, jurisdictional requirements, and more, not to mention temporary flight restrictions (TFRs), international Notices to Airmen (NOTAMs), nearby air traffic, and other information relevant to all pilots. Rules can also get fairly complex, especially in hyperlocal-situations. Educating and informing drone operators of these dynamic airspace conditions is foundational to a safe, efficient, and viable integrated airspace system. AirMap UTM provides a simple, effective and intuitive interface to publish local, state and national rules in a universal way.

AirMap provides pilots with the most complete assessment of the airspace available on the market today from our highly-rated AirMap mobile app.

For all countries, AirMap shows airspace information related to airports, heliports, controlled airspace, TFRs, NOTAMs, and No Fly Zones near schools, prisons, hospitals, power plants, dynamic sporting events, and special use or prohibited airspace.

As of Spring 2018, AirMap offers complete Contextual Airspace for more than 20 countries. With AirMap's Contextual Airspace coverage, drone operators get real-time information about local rules and airspace requirements as it relates to the parameters of a specific flight or mission.

And in an increasing number of countries, AirMap works directly with CAAS and other authorities to provide drone operators with complete certified coverage of all national-level rules, right from the AirMap app and from partner products and applications that have integrated AirMap's airspace intelligence services, representing over 85% of the global drone market.

Complete situational awareness for drone operators is critical to the safety and security of the airspace.



*AirMap Contextual Airspace (Japan)*



AirMap is the only UTM provider that reaches the majority of drone operators today through the drones and drone applications they're already using. AirMap's global airspace intelligence is available to operators through AirMap's highly-rated mobile app, as well as through direct integrations with DJI, Yuneec, senseFly, Intel, Kespri, and more, in addition to dozens of drone applications.

## Flight Engine

Even with complete situational awareness, an operator may need to communicate with an airspace authority, or vice versa, in the event of an emergency, a change in airspace conditions, or to request or grant flight authorization in controlled airspace. Sometimes it is also required for operators to give notice of flights to many different entities, such as rescue helicopters, law enforcement personnel, commercial helicopter operations, and more.

The AirMap UTM platform establishes two-way visibility and communication between airspace managers and the drone ecosystem with the AirMap app, the AirMap Airspace Manager Dashboard (AMD), and all integrated third party apps and mission planners.

Airspace managers can text a drone operator at any time to establish direct communication. AirMap UTM also facilitates manual and automated authorizations in a matter of seconds, making it easy for businesses and public safety agencies to deploy drones at scale.

Following more than a year of collaborative development with the United States Federal Aviation Administration (FAA), as part of the Low-Altitude Authorization and Notification Capability (LAANC) prototype, AirMap introduced one-tap tools for drone operators requesting digital airspace authorization directly from Air Traffic Control (ATC) in U.S. controlled airspace.

This model has proven to be compatible with a variety of technological and regulatory environments. AirMap UTM's digital authorization capability is deployed at several airports in New Zealand. And in Chiba City, Japan, drone operators can request digital airspace authorization to fly at three research and development test sites through the AirMap UTM platform.

## Traffic Engine

Once in-flight, AirMap's real-time traffic engine keeps drones, pilots, and the public safe. With the AirMap UTM platform, in-flight drones share telemetry, publishing real-time positioning information to the Airspace Manager Dashboard (AMD), where ATC manages traffic feeds for dynamic deconfliction of all aircraft.

Drone telemetry can be collected via AirMap's integrated APIs, on-board LTE/GPS module, satellite link, FLARM, ADS-B, and more. ANSPs can integrate third party radar feeds into AirMap UTM for real-time

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*The AirMap UTM platform establishes two-way visibility and communication between airspace managers and the drone ecosystem.*

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traffic intelligence for manned and unmanned aircraft. Operators receive real-time traffic alerts of nearby conflicting aircraft from the AirMap mobile app as well as integrated apps and mission planners.

The AirMap UTM platform is built for compliance, accounting for the vast majority of responsible drone flights. AirMap UTM is also compatible with Counter-UAS (CUAS) technology, which can be integrated into the Airspace Manager Dashboard (AMD). Please contact an AirMap sales representative for more information about CUAS capabilities.

## User Interfaces

AirMap UTM's e-registration and e-identification, geo-awareness, flight management, and traffic engine capabilities are available to the drone ecosystem via easy-to-use web-based clients.

AirMap's Airspace Manager Dashboard (AMD) for airspace authorities integrates seamlessly into existing ATM environments and are fast to deploy, with no hardware or software requirements, to provide easy and efficient airspace, flight, and traffic management functionality.

On the operator side, AirMap provides over 85% of the global drone ecosystem with the most complete geo-awareness, compliance assurance, and in-flight services available today. Operators access these services through AirMap's mobile apps, AirMap-integrated drones like those manufactured by DJI, Intel, Yuneec, and senseFly, and AirMap-integrated third party drone software applications.

## Compatibility

The drone industry has evolved into a rich global ecosystem with many hardware, software, and service providers across recreational, commercial, governmental, and academic sectors. As the industry evolves, the industry will grow in both size and complexity, making it imperative that the integrated airspace infrastructure that supports this ecosystem be open and adaptable.

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*The right integrated airspace system must be open, agnostic, and ubiquitous.*

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Both the NASA-UTM and U-space models recognize that the right integrated airspace system must be open, agnostic, and ubiquitous, allowing for any drone to access the necessary standards and protocol to operate in any airspace. In both NASA-UTM trials and the U-space demonstration, AirMap supported multiple flights by a variety of manufacturers and Ground Control Stations (GCS) without the need for additional hardware or software integrations on the part of the operator, manufacturer, or airspace manager.

Because AirMap UTM is built on AirMap's open platform, it is easy to deploy and hardware- and system-agnostic. Moreover, AirMap UTM, integrates seamlessly into existing air traffic control (ATC) systems and is flexible enough to support a variety of regulatory environments.

The AirMap UTM platform is built with only the most modern and scalable technologies. It is built with micro-services that run in containers, similar to how the major internet platforms achieve scale. In

addition, AirMap invests in IT architecture to give customers full flexibility in platform deployment. As a standard, AirMap operates on Microsoft Azure Datacenters in North America and Europe. For even higher security or more data-sensitive applications, it is also possible to deploy a version of AirMap locally in any country, as well as on-premise in any datacenter. Finally, the AirMap UTM platform is completely GDPR compliant to meet strict global data privacy and security standards.

## Summary

The future of aviation is integrated and cooperative, providing a safe and efficient operating environment for all aircraft. UTM is the digital infrastructure that is defining and developing the technologies needed to ensure this future.

While UTM has a long way to go in powering more complex missions like autonomous package delivery and vertical takeoff and landing (VTOL) commuting, AirMap continues to be the most trusted, accurate, and proven provider of out-of-the-box UTM services by the drone industry today and in the future.

If your organization is exploring integrated airspace solutions, we want to hear from you. Visit [airmap.com/utm](https://airmap.com/utm) to get in touch.

AirMap is the world's leading airspace management platform for drones. Millions of drones, hundreds of industry developers, and dozens of airspace managers and stakeholders rely on AirMap's airspace intelligence and services to fly safely and communicate with others in low-altitude airspace.

AirMap powers the vast majority of the world's drones through integrations with major drone manufacturers such as DJI, Intel, senseFly, and Aeryon Labs. Deployed in Japan, New Zealand, Switzerland, and the United States, AirMap leads the industry in delivering technology solutions for UAS Traffic Management (UTM).

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