

A New Digital Era of Aviation:

The Path Forward for Airspace and Traffic Management

1 Introduction

The world's shared and finite airspace will become considerably more complex in the future – and the pressure will continue to rise on our air traffic management (ATM) system. Commercial aircraft will be joined in the sky by increasing numbers of new aircraft – unmanned aircraft systems (UAS), urban air mobility vehicles, high-altitude pseudo satellites, sub orbital aircraft, super-pressurized balloons, supersonic aircraft, space vehicles and more. These new aircraft will have additional requirements for traffic management and will fly with novel concepts of operation. The ATM system needs to continue to adapt to handle the complexity, but also support longer term industry growth and innovation in respect to emerging aviation sectors.

Airbus and Boeing have a longstanding role at the heart of driving progress in international aviation. With our underlying commitment to safety, we share a common vision: a future airspace where new and existing users safely operate within a single airspace system – a system that enables the secure and efficient delivery of new aviation services to the entire community, while ensuring sustainable growth in the air transportation sector.

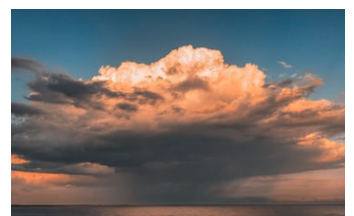
Realizing this vision will cement the industry's ability to contribute to sustainable economic growth – by facilitating trade and tourism, the aviation's global impact is estimated to be \$2.7 trillion [1] – as well as provide jobs, improve living standards, alleviate poverty and increase revenues from taxes.

A modernized air traffic management system is also an important part of the industry's strategy for meeting self-imposed environmental targets. Aviation is committed to cap its net CO2 emissions from 2020 (carbon-neutral growth) and to drastically reduce its contribution to global CO2 emissions by half by 2050 from 2005 levels [2] – an ambitious target.

Though significant challenges must be overcome by industry, the benefits – continued improvement in air transport safety, capacity improvements, sustainability, and cost reductions – will accrue to all of us. We are on the cusp of the Third Era of Aviation, which will bring all-new aviation services to the public, improving access to remote areas and providing ever-more efficient ways to move people and freight that reduce aviation's environmental footprint and road congestion.

The objective of this paper is to showcase how UAS Traffic Management (UTM) can contribute to the safe and efficient advancement of future airspace, as well as to raise awareness on the need for new global standards and regulations to enable seamless and interoperable progress.

UTM will offer digital and automated services which can pave the way for future services and new concepts of operation, while working alongside and converging with current ATM advancements. The system must be interoperable across countries, and compatible with ATM upgrades meaning the development of relevant global standards is of high importance. This is both a challenge, and an opportunity, for regulators and authorities as traffic management evolves. Industry can play a greater role helping to address these challenges, and in turn, help realize the benefits arising from ongoing innovation across the aviation sector.



Third Era of Aviation

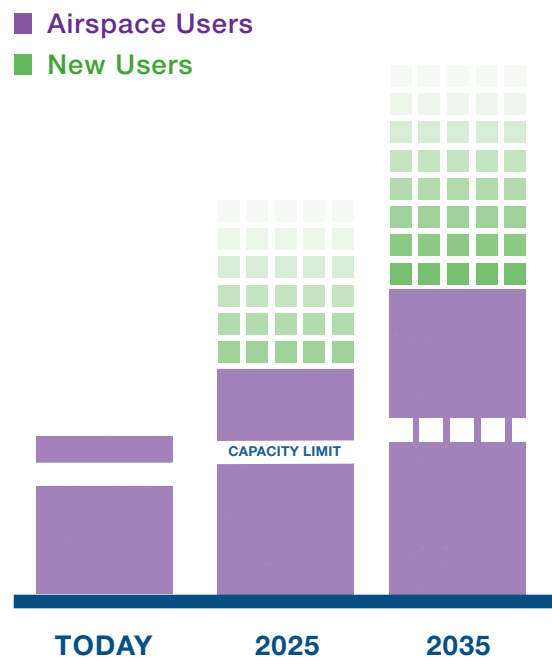
“Aviation is at the dawn of its third major era, building on the foundation laid by the Wright brothers and the innovators of the Jet Age in the 1950s. Aviation’s third era is enabled by advances in new architectures, advanced engine thermodynamic efficiencies, electric and hybrid-electric propulsion, digitization, artificial intelligence, materials and manufacturing...” – Joint statement from chief technology officers of seven of the world’s leading aerospace manufacturers, Paris Air Show, June 2019

New airspace users

New aircraft will introduce an advanced mix of flight profiles and capabilities. Airspace will need to accommodate a multitude of new operations with differing performance standards and priorities. For example, small UAS and mobility vehicles in urban areas will need to be flexible in nature; space vehicles and high-altitude pseudo satellites may need special handling as they transit the main airspace structure; and passenger aircraft will want priority over other types of operations as they approach and depart airports surrounded by increasingly busy and complex airspace.

Air taxis and drone delivery vehicles will increasingly fly on-demand and require a flexible traffic management system within these low altitudes. Traffic management in higher altitude airspace will encompass diverse craft including unmanned balloons, airships and solar aeroplanes capable of persistent (months) of flight. Future traffic management will likely exploit the collaborative exchange of trajectory intent and federated, automated and risk-based deconfliction.

New and adapted flight rules and procedures will be required to efficiently manage these increasingly dynamic operations of differing priority and types. The scale and complexity of these operations will continue to expand, posing an even more significant challenge to our existing ATM system.



2 UTM

UTM is an enabling set of systems required to safely and efficiently manage new vehicle and operation types, and their integration with existing operations at all altitudes. Future airspace management will need an upgrade towards more digital services. UTM will support and accelerate this transformation.

Functions of UTM

- Safety risk management
- Dynamic airspace management
- Information and advisories
- Instant communication and coordination
- Contingency management

Today’s UAS operations are limited or restricted in many types of airspace to keep them away from manned aircraft. UTM will facilitate safe integration, while ensuring the increasing number and complexity of UAS missions are appropriately coordinated and routed. The need for UTM becomes even greater for uses such as urban air mobility, which include complex on-demand passenger-carrying operations in busy areas.

Just as the internet was built as a distributed system, UTM will need to evolve in a similar way, comprising dozens of interconnected microservices, or UTM service providers, dedicated to operational support of vehicles and operators. Microservices can include the provision of surveillance, weather and airspace information at a national and international level. A UTM system also will include coordination protocols and underlying network and telecommunications infrastructure.

Stakeholders in UTM

- General public
- UTM service providers
- Civil aviation authorities (regulators)
- Local authorities
- Air navigation service providers
- Existing airspace users
- Operators of new aircraft types
- Aircraft manufacturers
- Infrastructure providers

It is important to note that UTM is not envisioned to be a single central system, but a networked collection of services working together with common rules. The distributed, service-based architecture of the system gives it advantages: it opens the system to many service providers who can adapt as the market evolves and needs change; it allows flexibility for new types of operations and a broad range of vehicle types; and it gives flexibility to cost of serving and adapting to market needs, while allowing regulators to maintain safety, access and fairness in the airspace. The general public has an increasing stake in aviation, particularly when it comes to low-altitude operations in urban environments. UTM will help to proactively, objectively and transparently address broad societal concerns such as noise.

We believe UTM is a necessary step to enable new operations that will be integrated into the airspace system. UTM operations will benefit from new technology, new systems, new rules, new procedures and new business models. UTM should be seen for what it can be: the eventual future of digital services for all airspace users.

UTM interoperability

Interoperability and compatibility are critical for stakeholders with interests in all parts of the airspace – from low to high altitude and everything in between. Interoperability enables safe and efficient coordination, and directly supports the safety and efficiency needs of UTM. Compatibility means that multiple providers sharing the same airspace can coexist, without causing negative consequences for users. In the context of UTM, interoperability can be divided into four types:

- 1. Interoperability between service providers:** This allows service providers to effectively interact with each other to ensure safe and scalable operations.
- 2. Interoperability between different vehicle and operation types:** This defines how different operations and vehicles interact with one another. This includes interactions between conventionally piloted and unmanned aviation. It also covers how entry and exit points are treated for operations that traverse multiple types of airspace and interact with multiple types of service providers.
- 3. Interoperability between countries:** This defines how countries interact with each other, including, but not limited to, the rules and coordination required to conduct cross-border operations. In many parts of the world, especially Europe, airspace boundaries do not correspond to sovereign borders between countries. Therefore, an operator may fly a mission that must access airspace managed by two different countries, even though the mission is contained within the borders of one country.
- 4. Interoperability with existing ATM systems:** It is important to recognize that UTM will progressively evolve alongside the existing ATM system and finally evolve towards a unified traffic management system. During these evolutionary phases, the two systems must interact safely and efficiently in support of one another.

An accepted solution will require the active engagement of all relevant airspace and aviation stakeholders, existing and new. If we do not come together to address this challenge, then there could be missed opportunities for society and business.

UTM design principles

Recognizing that UTM and ATM will converge, we need a solid foundation. Core principles at the heart of UTM include:

1. **Safety:** Safety is paramount. UTM must ensure the highest level of safety is maintained for all airspace users.
2. **Scalability and flexibility:** UTM must support high numbers of an increasingly diverse range of aircraft types and performance, and their concepts of operation. Airspace is a shared resource and must be able to be adapted and managed dynamically.
3. **Interoperability and compatibility:** As described above with a critical focus on the interface with existing ATM systems - both national and regional.
4. **Reliability:** UTM must be sufficiently reliable and available for safe operation at scale. It must be resilient to failure.
5. **Security:** UTM must be secure for safe operation.
6. **Open architecture:** UTM must provide a fair ground for commercial participation in the generation of solutions and provision of services.
7. **Open service:** UTM must be available to any airspace service provider or user who meets the necessary requirements.
8. **Future-proof:** UTM must have built-in flexibility to support vehicles, missions and systems in all environments and airspaces including future, unforeseen uses.
9. **Performance-based standards:** UTM should, as far as practicable, be technology-agnostic.
10. **Fairness:** UTM must ensure that all stakeholders have access to airspace based on a clearly defined set of rules and prioritizations. UTM must support all operators and service providers, taking into account competing needs and system limitations.
11. **Cost-effective:** UTM must provide cost-effective and accessible service to all airspace users. It should help reduce the overall cost for traffic management services and infrastructure.
12. **Flight efficiency:** UTM design and operational concepts should effectively balance the desire for user-preferred trajectories with airspace capacity constraints and safety benchmarks.

3 Safety

Safety is the number one principle underpinning the development of UTM. In 2018, more than 46 million commercial airline flights safely transported more than 4.3 billion passengers to destinations all around the globe [3]. With an accident rate of 1.35 per million flights [4], commercial air travel is the safest mode of transportation [5] and data shows it's getting even safer [3,5]. Maintaining, or even improving, on this high standard of safety for all airspace users is paramount.

The diverse mix of new operations places additional importance on the ability to effectively calculate and manage risk for new operations with different risk profiles. New risk analysis methodologies will focus more on the type of operations (and their interactions) rather than a defined safety target for the airspace as a whole. Real-time risk assessment and monitoring will allow instant identification of any degradation in service provision, or conformance. A more automated traffic management system will help reduce air traffic controller and pilot workload in increasingly complex airspace.

Safety performance criteria should be based on the risks associated with UTM as an integrated part of the airspace system. These criteria must include consideration of the risks to all airspace users, and to people and property on the ground. The high standard of safety required can only be achieved if it is “built in” from the outset.

Achieving safety is more than just sound design. Safety assurance must be considered across the entire lifecycle of UTM – from its initial design to its implementation, operation and eventual evolution. A strong safety culture of approved and experienced aviation design and operating organizations will be key to achieving a high level of safety assurance.

Consistent with the global pursuit for ever-safer aviation, UTM and the supporting regulatory framework must foster a continuing safety culture. Flexibility is needed to exploit the safety enhancements emerging through increasing automation including sensing technologies, artificial intelligence and machine learning. UTM should be designed with features like real-time safety performance data monitoring, conformance monitoring and predictive hazard analysis.

4 Modernizing ATM

While the concept of UTM was born out of the challenge of integrating low-level UAS, it has provided a much broader opportunity to rethink the concept of ATM for all users. The UTM concepts being developed today are establishing the building blocks for the management of all airspace, for all airspace users, into the future. We envision a phased evolution of UTM capability and the progressive transition of proven functions and services to the existing ATM system. This will be a gradual transition. People will continue to fulfill vital roles for years to come, and we will need to work closely with controllers and pilots to make sure that intermediate levels of autonomy do not compromise the safety of ATM and UTM systems.

In time, UTM services will expand to all airspace and airspace users - enabling safe, more efficient and environmentally sustainable utilization of airspace for all. Investment is needed now to lay the foundations for the future. It is therefore an opportune time to start considering ATM / UTM convergence in the choice of solutions for traffic management modernization.

Worldwide, UTM systems are under development and localized solutions are creating silos. The sooner we have agreement on the future of ATM/UTM, the sooner collaboration can begin, and we can ensure global harmonization and interoperability of those UTM systems as well as with existing ATM systems.

The evolving role of the air traffic controller

Ensuring the safe and efficient management of air traffic is a demanding task. Air-traffic controllers can be better supported by automated systems to help them manage an increasingly complex airspace environment. Autonomy can significantly reduce workload and allow controllers and pilots to focus on higher-level system management, where controllers and system engineers will work in real time to refine or change parameters to ensure optimum performance of the system.

Managing Our Skies: The Integration of ATM & UTM

TODAY: SEPARATE UTM & ATM

NEAR TERM: UTM & ATM CONVERGENCE

FUTURE: UTM & ATM INTEGRATED AIRSPACE



Future Integrated Airspace

- > Safe
- > Scalable and flexible
- > Interoperable and compatible
- > Reliable
- > Secure
- > Open architecture
- > Open service
- > Future-proof
- > Performance-based standards
- > Fair
- > Cost-effective
- > Flight efficiency

■ ATM ■ UTM ■ Integrated

5 Industry action and next steps

UTM is part of the future: unprecedented innovation is taking place in the aviation industry. UTM will help bring huge benefits to the global community, and a much-needed catalyst for broader airspace and ATM modernization that will enable new industry growth and opportunity. However, UTM is being implemented today in a patchwork of different standards and regulatory frameworks. Unless we follow a cohesive, global approach, it will result in non-interoperability, inefficiency and missed opportunity. To prevent this from happening, action must be taken:

1. **The development of a global action plan:** A phased plan for the development and implementation of UTM with a continued focus on safety is needed.
2. **Creation of a global airspace operational concept and standards:** A single global airspace operational concept, with associated standards, needs to be defined and adopted. This concept must incorporate the needs of existing and emerging airspace users and the necessary UTM system.
3. **A unified air traffic management system:** New ATM concepts for all airspace users that facilitate the safe integration of new vehicles and technology are needed. UTM development must have provisions for evolution in order to support a future “integrated airspace and ATM” operating concept, not just the needs of the here-and-now small UAS sector.
4. **Support and action by states:** States to support new airspace users and work with the relevant authorities to help progress UTM performance-based standards for safety, technology and security.
5. **UTM plans:** Existing plans for UTM should reflect emerging opportunities, taking into consideration interoperability between UTM systems, and between UTM and ATM systems.

Airbus and Boeing will work together with relevant industry stakeholders to support concrete steps forward. As an industry, we need to collectively rise to the challenge, and leverage an important opportunity to advance aviation and the significant benefits it offers the world. ICAO (International Civil Aviation Organization) and ICCAIA (International Coordinating Council of Aerospace Industries Associations), which represents the aeronautical industry organizations at ICAO, are essential to achieving this objective through the development of a globally consistent framework of standards and regulations.

The last ICAO General Assembly held in September 2019 paved the way for industry to strengthen its role in fostering global aviation innovation working in partnership with ICAO. The advent of UTM, and more broadly the acceleration of aviation innovation, were the subject of multiple contributions (Working Papers), most of them presented by industry under the aegis of the ICCAIA. Those papers covered diverse, but essential and complementary, topics to enable for sustainable innovation in aviation, proposing new ways to collaboratively develop the required future standards and regulations.

The contribution of industry supporting the development of innovations and future technologies to advance global aviation is already showing promising results, including areas like ATM / UTM, as well as related subjects like cybersecurity, digitalization and artificial intelligence, the evolution of airports, ATM capacity, and sustainability, etc.

As technological innovations are developed to improve and modernize the whole ATM system, industry can play an essential role: helping to ensure the coherent evolution of the enabling and related elements of the aviation ecosystem, so as to guarantee that the future traffic management system remains safe, secure, harmonized, sustainable and interoperable.

As we continue to pursue innovation in respect to new aviation concepts, technologies and systems, so too should we explore innovation in respect to how industry can better support the dialogue with regulators and authorities. This will be essential to realizing the full scope of potential benefits from this era of aviation innovation. UTM provides here and now the opportunity for ICAO to explore a greater role for industry leadership in supporting the development of concepts, standards and regulations.

References

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[4] Five-year accident rate for the period 2014-2018. From 2018 Airline Safety Performance data, International Air Transport Association (IATA).

[5] International Civil Aviation Organization Safety Report, 2018 Edition