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Throughout the pandemic, aviation has proved to be remarkably resilient and adaptable. Here, I fully appreciate the massive losses, the failures of several airlines, the huge amounts of public money put into the industry and the tragic impact on the lives of many who worked in aviation or who relied on aviation for their livelihoods. However, the industry has survived and it has adapted.

Airports have changed their business models and have sought to reassure passengers, for example by reducing points of contact and by enhancing cleaning regimes. They have put in place test centres and, in some cases, vaccination centres. Runways have been used for aircraft storage, terminals have been temporarily closed and some have used the reduction in traffic to accelerate planned maintenance and infrastructure improvements.

Airlines have retired aircraft early, have put others in storage and have deferred or cancelled new aircraft purchases. They have also worked to reassure passengers by improving aircraft cleaning; some have blocked off middle seats and they have adapted to changing and unpredictable travel restrictions with passengers booking later and seeking more flexible tickets. Services have been rapidly ramped up – and down – as the epidemiological situation has changed and as governments have adapted their rules.

Staff have responded magnificently to this unprecedented crisis. Many, unable to work normally, have volunteered to help in contact tracing or vaccination. And we have seen a massive effort to make sure that safety is ensured as staff come back to work at full intensity – both in the air and on the ground – for example in air traffic control centres. This summer traffic reached around 70% of 2019 levels for the network as a whole but in some areas and at some times – for example weekends in Greece – we have seen traffic at close to ‘normal’ levels.

Air traffic management generates some inefficiency leading to greater fuel burn (up to 10%) and this is particularly the case when the system is operating close to capacity. Tackling this inefficiency will not be easy but it needs to be done. We’re already seeing Free Route Airspace becoming the norm and the pandemic has given many airports the opportunity to dramatically increase their use of Continuous Climb and Continuous Descent Operations. The challenge is to keep this going as traffic returns.

Longer term, we see ATM becoming more focused on enabling airspace users to choose their own, optimal trajectory. It will be a major change and it is one for which we at EUROCONTROL, in our role as Network Manager, are investing around €300 million in new systems and a new operations centre.

One way in which we expect to see major developments in the coming years will be the types of aircraft in the skies. Some of this will come from changes in propulsion – to electric and hydrogen. We are also seeing development of new supersonic aircraft, very high altitude aircraft and even airships. However, the most visible change may well be the use of drones and electric air taxis.

All of this presents a real challenge as many of these new types of aviation will be sharing airspace with others and with conventional traffic. They will all have different capabilities, different speeds and different preferred trajectories. Bringing them all together efficiently – and, most importantly, safely – will require major changes in the ATM sector.

I am confident that aviation will respond and adapt. We must do so – all while maintaining (or improving upon) our safety record. Even as we emerge from the pandemic, our objective should not be to get back to where we were, but rather to take the next steps forward.
2021 has been a key year for the U-space. The EASA Committee published last 22 April, the Commission’s Implementing Regulation of the Regulatory Framework for U-Space. Most of the European countries are getting ready to have their U-space systems up and running for 2023, when the regulation enters into force. This is a great step for the drone industry and will contribute to open European skies to new actors, transforming the world of aviation as we know it.

In this context, the Spanish air navigation service provider, ENAIRE, has entrusted Indra in a public tender with the deployment of its U-space system in Spain, which will cover all drone operations in national territory, in an ambitious project that will open up the Spanish airspace to all U-space users.

Indra will contribute, together with ENAIRE, to the early development of a completely new sector, with a system which is the first ‘second generation’ U-space systems to be deployed in Europe, compliant with the regulation from the design phase.

The system includes both CISP (Common Information Service Provider) and USSP (U-space Service provider) platforms, enabling a federated architecture since the first operational phases of the project. This U-space system will follow the ‘single CIS Provider’ architecture from U-space regulation, being ENAIRE a pioneer in Europe with the role of the Common Information Service Provider, becoming not only a national but also an international reference.

The CISP acts as the single point of truth of the U-space environment, providing a complete view of the airspace and applicable rules. Besides, it provides critical services, as flight plan authorisations by the competent authorities, integration with current ATM system or integration with other ENAIRE’s AIS and operational systems, as ICARO or INSIGNIA. It will also allow the connection of privileged users to exercise their responsibilities towards the services.

The second component of the platform is the USSP. A solution to which the drones operators are connected to plan and validate their operations, request U-space flight authorisation and monitor in real time their flights. USSP will receive from the CISP all airspace information necessary to provide a complete situational awareness to their operators and pilots users ensuring the safety of these new UAS operations and those already existent in the current airspace.

A full set of validation campaigns over the complete system and interface with ATC is established to guarantee the performance and allow for an earlier entrance of the services. The Spanish NSA, AESA, will supervise the full process for a better understanding of the functionalities, architecture and services with a view on the certification of ENAIRE primarily as CISP.

The platform will be ready for operational deployment before the entry into force of the new regulation in January 2023. The project can be extended other 24 months.

The project is divided in two main phases:

- **Phase I:** with a delivery early 2022, in which a first version of CISP and USSP will be deployed and it will allow the validation of the different drone operations and start the certification process.

- **Phase II:** a new version of the system will be ready in 2023, fully compliant with the regulation and with the possibility of adding new USSPs that will connect with ENAIRE’s CISP. With this approach, the competitive market of U-space service providers will be open in Spain in 2023.

The platform will be highly digitalised and automated, which will provide each user with agile and secure access to the U-space. “The perfect integration of the different components from its design”, ENAIRE’s U-space Project Manager explains, “as well as the careful distribution of functions among them, is one of the factors that have made this U-space platform one of the most sophisticated”.

Indra and ENAIRE will contribute to the growth of a market that will benefit both U-space users and society as a whole. Through this system, drone operations will grow exponentially ensuring a safe integration into the airspace with current conventional operations managed by air navigation services and will be a first and necessary step in the development of Urban Air Mobility.
Indra, as one of the most innovative companies in the world, is transforming the aviation as we know it. With this purpose, Indra has a complete portfolio of UTM/U-space solutions that can give answer to the more demanding needs of the customers worldwide.

**Indra UTM Hub:** is the FIMS/CIS solution developed by Indra. Its flexible design allows customisable service deployment to meet your needs. UTM market and regulations are constantly evolving, and the flexibility of our system makes possible a smooth adaptation to new challenges. This cloud-based platform can provide different services depending on the customer needs, including: Geo-awareness and Drone Aeronautical Information Management service, Registry and Users Management service, Tracking and Network Id services, Emergency management alerts, etc.

This solution is complemented with the UTM Connect platform that is the USSP multiprotocol developed by Indra.

**Indra UTM Connect:** the UTM Connect platform, oriented to drone operators and pilots, provides end-to-end services needed for the safety management of drone operations during the pre-flight, in-flight and post-flight phases. This platform is available as a web service and through a mobile app with a full “APIfied” design to simplify integration with other systems or applications enabling multiple drone operations. This platform cloud-based can provide different services depending on the customer needs, including: Flight Planning and UAS Flight Authorization service (including the Strategic Deconfliction service), Geo-awareness, Registry and Users Management service (including crew and fleet management), Tracking and Network Id services, Conformance and Tactical conflict management services, Emergency Management service.

**Indra ARMS C-UAS system:** Indra’s ARMS is a simple, flexible and scalable solution that provides the most advanced tools to combat UAS threats. From micro drones (i.e. DJI Phantom family) to large UAS, Indra’s ARMS manages to take a step forward in the detection of these devices, surpassing the surveillance capability of traditional services. This system integrates a wide variety of high-tech detection and identification sensors. This solution integrated with the rest of Indra’s UTM platforms is able to clearly distinguish between possible hazardous UAS operations and those UAS operating in a cooperative way.

**UTM/ATM interface:** Indra, as an experienced company in ATM solutions, is leading the definition of UTM/U-space and ATM interface, having integrated already UTM Hub with several of Indra Air Automation solutions. This interface will discriminate which information is relevant to air traffic controllers avoiding to overload them when the UAS traffic increases in the near future. Among the information that may be shared by UTM are the drone tracks with their alerts.

Indra’s proven trajectory in developing, deploying and evolving ATM systems, combined with our state-of-the-art UTM Hub platform (the U-space FIMS/CIS) represents the best choice to unleash the potential of drone applications and open new skies for commercial exploitation.
“COMMERCIAL AIR TAXI OPERATIONS EXPECTED IN 2025, AUTONOMOUS FLIGHT IN THE NEXT DECADE”

Vertical Aerospace’s VA-X4 electrical Vertical Take Off and Landing (eVTOL) vehicle is expected to enter commercial service in 2025 - Eduardo Dominguez Puerta, the company’s Chief Commercial Officer, looks at the challenges ahead and the road beyond to autonomous flight.
Can you provide a brief overview of your eVTOL programme?

Our VA-X4 is a vertical takeoff and landing aircraft, fully electric, zero emissions and, initially, with a pilot on board. We thought that for certification and public acceptance purposes this is the best place to start. We believe that autonomy will develop over time once the regulatory frameworks are in place.

However, we’re also trying to upload as much technology as we can and prepare for the autonomy step-change that will probably happen during the 2030s.

We have gathered a great group of partners such as Rolls-Royce, Honeywell, Microsoft, GKN and Solvay to help us on the development, certification and industrialisation of the build.

We also have an interesting strategy in the partnerships we are building with our customers. We want to be an original equipment manufacturer (OEM) and provide vehicles to experienced customers who know how to operate them in an aeronautical environment and who already have a network of passengers and routes in place.

We are aiming at certifying the vehicle at the end of 2024 under UK Civil Aviation Authority (CAA) and European Union Aviation Safety Agency (EASA) Special Condition Regulations. We plan to start producing at scale after that, introducing the vehicles into service in 2025.

We have a plan to increase and scale production to volumes that are close to the car industry, so we are targeting a thousand aircraft per year in 2026. We know many other things will have to be developed in parallel and a full ecosystem will need to be created, including infrastructure, energy and integration with other means of transport.

Airspace integration, so these vehicles can be managed in our urban skies and integrated with traditional air traffic managed by air navigation service providers (ANSPs), is a major part of this.

What are the performance characteristics of the vehicle?

Take-off weight will be around three tonnes and it can carry up to four passengers with a pilot. It has an expected range of a hundred miles with a maximum speed of 200 miles per hour.

There will be different mission requirements. Some customers will want to use these vehicles to fly passengers to airports from city centres and the wider catchment area. This will require a range of between 20 to 50 miles.

We also think there will be an increase in the performance and capabilities of batteries, in terms of energy and power density, we so foresee an increase in range and payload. We see that market expanding to point-to-point routes, linking cities that today suffer from a lack of infrastructure or connectivity. That will complement existing means of transport in a much more distributed, and I would say flexible, way. We see these services enabling economic development of those regions.

So it’s not just for the urban skies, these aircraft will fly routes that are currently covered by general aviation aircraft.

Yes, we will see some natural additions to general aviation and the replacement of light helicopter missions. Our vehicles are going to provide a much lower noise footprint, will have far fewer emissions and will be more economical. That will create new opportunities.

I also see additional markets opening up in inter-island transport sectors and developing services to isolated areas. There are many island groups in the world usually connected by networks of ferries. These services are not fully optimised and they have a heavy carbon footprint.

We also see a new market in transporting tourists who today have to travel by minibus. When you land at your tourist destination after a nine hours’ flight you still need to get into a minibus and drive to your destination for an hour on roads that can be dangerous and uncomfortable. Then there are traditional sightseeing excursions today provided by helicopters.

In all these sectors we believe that we can provide services at a much better direct operating cost than helicopters, with increased safety – due to redundancy and no single point of failure – and much improved sustainability.

How much airspace integration work – both inside and outside an urban environment – have you done?

We want to create ecosystems through partnerships. We understand you cannot create an industry on your own – you need to rely on competent partners.

Airspace management is a very national-centric service and requires partnerships with ANSPs. But “classic” ATM is going through a major transformation. Digitalisation is required not only to manage the future in terms of autonomy and to ensure autonomous vehicles can communicate with piloted vehicles, but also to improve the capacity and management of airspace.

ATM is a very traditional industry and still relies on UHF, voiceover and legacy technologies. ANSPs understand that
Flying in a changing sky

Air Traffic Management is evolving. Leonardo is continuously innovating; investing in Research and Development to ensure that over 150 customers employ leading-edge technology for all flight phases, including ATC systems, surveillance sensors, cyber security, communications, weather radars and navigation aids; ensuring efficient and reliable ATCO’s support.

Inspired by the vision, curiosity and creativity of the great master inventor - Leonardo is designing the technology of tomorrow.
transition is required and we want to be part of that transition. Regulators have also been very active in areas such as vehicle certification and regulations such as U-space that define rules for lower airspace management. These rules will enable the introduction of drones and other lower-altitude airspace vehicles and support integration with higher airspace classes and more classical traffic. So, I think the moment is right. I can see that all the different stakeholders have the same needs and are talking along the same lines.

How do the U-space regulations, developed for drones, impact what you are doing and have you thought about what communications methods you’re looking at in terms of conspicuity and talking with controllers – if you have to?

We are a UK company and already have had very collaborative discussions with NATS. The U-space regulations will enable drone services but these types of missions are usually very short and localised in time and space. To support large vehicle operations there will need to be a real integration between U-space rules and classical ATM. That still needs to be worked out. I believe that EUROCONTROL, national ANSPs and the European Union - along with the UK Future Flight programme - have been investing heavily in this work and will start demonstrating real-world use cases.

We will need to demonstrate interoperability between vehicle classes and different OEMs, and this is something that is very important to us. We need standards groups that will define some of the rules and technical requirements that all vehicles will need to fulfil, so we can integrate them into the same system.

I think we need to be humble and we need to be collaborative. As an OEM, we cannot define the rules and the regulations; ANSPs and regulators are much better placed than us in determining airspace definition. We will provide all the input that is required to make sure the rules and regulations are properly defined.

When do you see those first demonstrations taking place?

We would like to undertake some demonstrations in the UK in 2024. By then we will have vehicles manufactured and the flight tests for certification will be under way. Between now and then we will need to continuously engage the public; people need to see, feel, touch and imagine what is coming so that they will be able to feel they can support it.

We have already signed a conditional pre-order with Virgin Atlantic and we plan demonstration flights during 2024 in London in preparation for the expected commercial service roll-out in 2025.

“We want to be an original equipment manufacturer and provide vehicles to experienced customers who know how to operate them in an aeronautical environment”
We’re trying to gather all the key stakeholders, such as NATS, Heathrow Airport, the Department for Transport in London and other airports such as Farnborough and London City, to understand all the preparation work that needs to be done.

**How do you plan to introduce autonomy into the system – not just autonomous flying, but an autonomous ecosystem?**

Through partnership. Honeywell is developing our flight control systems and we need to simplify to the maximum extent possible the pilot’s tasks. We need to protect the envelope these airplanes will fly in, so we minimise the risk and offload many of the traditional heavy piloting tasks.

The biggest hurdle I see for autonomy is not technology. I’ve seen the integration of radars, LiDARs, machine learning, machine vision, artificial intelligence, all that linked via flight controls so the aircraft can sense and avoid. All that exists. The question is, what are the means of compliance and what are the regulatory checks that need to be made on new technologies such as AI and machine-learning?

It’s not easy for regulators to ensure that these algorithms will do what they are built to do. Shoot for the moon, you will get to the moon. But sometimes it’s better to shoot for the sky, learn how to fly and then you will get to the moon.

**How do you regulate non-deterministic machine learning?**

I think that’s a question that regulators, industry, academia, science, will need to solve together. As these new technologies are developing, we are becoming more capable at gathering and analysing data and simulations. But the regulatory landscape needs to move, from a requirement-based to a performance data-based type of certification.

In the future we will go beyond that and have some type of simulated, synthetic scenarios that we can analyse and understand without putting anybody in danger.

**Can you paint a picture of what the urban sky is going to look like in 2035?**

It will depend on what the investors will do. There has been a great deal of hype. Five years ago, we were told that by now we would have our coffee and pizzas delivered by drones. I think we have all realised that some of these ambitions need to be more pragmatic.

I don’t see a future in the near term where the urban sky is full of drones and eVTOLs. I think we will start with very controlled operations – not on-demand, but probably scheduled – from places where infrastructure and airspace control already exist. It will develop progressively.

I can picture the sky in London in 2025 and beyond where some of those machines will be flying up to 5,000 feet – which in terms of the noise footprint will be nearly imperceptible - and we will get used to seeing them there. We already see them there in the form of medical and public services helicopters.

So, I think it’s going to be progressive, I think it’s going to be controlled, and I think it needs to be on real-use cases that provide value.

I think it’s important to keep a system-of-systems view of how that reality will look like. I think that is fundamental in terms of architecture and integration. But we need to be humble, and I think we need to continue with the “crawl, walk, run, fly” approach which has always been the basis for any successful technological or industrial development.
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HOW TO BRING URBAN AIR MOBILITY TO LIFE

The launch of UAM services in cities will require the development of an advanced aviation ecosystem on the ground and in the air, explain Jörn Jaeger, Senior Specialist for Aerospace Management & Infrastructure and Barbara Zygula, Regulations & Standards Analyst at Volocopter.

Urban air mobility (UAM) - the aerial transportation of passengers and goods in an urban environment - is enabled by new aircraft with a distributed propulsion system, vertical take-off and landing (eVTOL) capabilities, low noise, highest safety, low infrastructure requirements and cost-efficient operations. On top of that, eVTOL will also contribute to maintaining clean air in cities by being emission-free in flight. Volocopter is positioned to launch an immediate and scalable service with a complete, integrated UAM system and provide quick, safe, and seamless mobility in cities.
To make UAM a scalable, seamlessly integrated reality, a full ecosystem is necessary. Volocopter leads and cooperates with partners in air traffic management, infrastructure and operations to build the ecosystem required to bring urban air mobility to life. “At Volocopter we are not only designing and manufacturing the aircraft but will also become an air operator and maintain our fleet under Part-145 approval”, explains Jörn Jaeger, Senior Specialist for Aerospace Management & Infrastructure. “We are developing vertiport design, our VoloPort, including ground support equipment, and preparing for vertiport operations. And airspace integration is high up on the list of activities. We are also working on VoloIQ, a fully integrated digital platform solution to cover everything from ground and flight operations to booking”, he adds.

KEY CHALLENGES

Although UAM could take off using the current regulations, infrastructure or air traffic management (ATM), the way to its scalability involves challenges. This new form of mobility is not only about introducing a new aircraft type, but also integrating a new set of operations into our society, gaining public trust, and creating the whole regulatory framework around it.

The first topic to tackle is aircraft certification. To operate commercial passenger flights in Europe, the eVTOL needs to be certified according to the highest safety standards provided by the European Union Aviation Safety Agency (EASA) SC VTOL, which is 10-9 for catastrophic failure conditions. These considerably exceed safety levels of drones, helicopters, or conventional general aviation aircraft to allow flights over congested areas from a safety perspective.

While the end goal for Volocopter’s air taxi service is to be autonomous, there will be a pilot aboard for initial operations. The main reason for this is to allow earlier entry to service and to help public acceptance of this new technology. VoloDrone flights, however, will be remotely piloted. This means that two different regulatory regimes might apply to eVTOLs: manned or unmanned, which also brings some challenges.

An important topic, especially in the context of operating in an urban environment, is ground infrastructure. While VTOL aircraft can use existing heliports or aerodromes, such sites are not sufficient to connect desired UAM destinations as operations scale. Hence, dedicated take-off and landing sites, commonly known as vertiports, will be important introductions to a city’s physical infrastructure to support UAM operations. Vertiports’ key differences to traditional heliports are higher passenger throughput, other flight obstacle restrictions, lower noise signature and battery charging infrastructure, essential for eVTOLs operations.

Regarding airspace integration, the aim is to fly safely, efficiently, and to coexist with all other airspace users. The creation of a traffic management system is a great yet complex opportunity for UAM. Firstly, this system will need to be harmonised with existing ATM systems and procedures for flight operations touching controlled airspace. Air traffic controllers (ATCOs) should be involved as little as possible for standard operations. At the same time, as a different airspace use with partially new airspace users is envisaged specifically at Very Low-Level airspace (VLL) and in urban areas, new systems, procedures, flight rules and roles must be established, especially in previously uncontrolled airspace. While in Europe we see a more integrated approach with U-space airspace, other regions think about a further subdivision of this airspace in airspace for UAM and smaller UAS (though determining the criteria for differentiation could become difficult). In any case, the airspace concept must be developed while considering many more stakeholders. These include but are not limited to air navigation service providers (ANSPs); civil aviation authorities (CAAs) and authorities for safety and security; vertiport operators and airspace users such as general aviation, and operators of flight in public interest such as police, helicopter emergency medical services/search and rescue (HEMS/SAR) missions. In addition, due to the local nature of operations, regional authorities and municipalities will come into (the aviation) play.
“UAM is not only about new aircraft but about new concepts and solutions in various aviation domains”

“In the future we can expect traffic management systems and procedures for incumbent and new flight operations to move towards integration,” explains Barbara Zyguła, Regulations and Standards Analyst. However, for now, the safety of their coexistence is achieved by separating these kinds of traffic, for example by means of dynamic airspace reconfiguration or establishing dedicated corridors for UAM services. “In this context, a challenge for airspace management systems and procedures is to allow for quick airspace (re)configurations and ensure a seamless and secure information exchange between the involved stakeholders, including reactions to off-normal situations”, she adds. Both manned VoloCity or an unmanned VoloDrone need to be integrated to the airspace, properly equipped, and able to interact with their respective traffic management service provider.

To develop concepts and solutions, Volocopter is participating in various projects aimed at further development and validation of traffic management concepts which are formative in launching the industry. Volocopter successfully demonstrated the integration of Volocopter UAM flights in ATM and Unmanned Air Traffic Management (UTM) systems with flights at the Helsinki International airport in the frame of the Single European Sky ATM Research (SESAR) Gulf of Finland project two years ago. As a result, Volocopter has become a consortium member of the CORUS XUAM project, which is one of the few European lighthouse projects encompassing exceptionally large-scale European-wide UAM demonstrations and the definition of the concept of operations. We also support the evaluation of concepts such as flight-centric sectorless traffic management, system wide information management (SWIM), airport collaborative decision making (A-CDM), airport operations plans (AOPs) or trajectory based operations (TBOs) to be adapted for the UAM industry.

Because of the nature of the short-distance flight, the subject of minimum flight heights must be addressed. ICAO’s Rules of the Air, which are also reflected in the Standardised European Rules of the Air (SERA), include limitations on flights above congested areas, and local governments can restrict or alleviate the intended altitude and routes of UAM operations. Moreover, the coverage of Communications, Navigation and Surveillance (CNS) services in urban zones can be limited, due to low flight altitudes. The challenge includes the introduction of reliable detect-and-avoid mechanisms. Another factor will be weather information: current meteorological services may not be suited enough for UAM city weather reports, where local gusts or changes of temperature may occur. Volocopter has identified all those urban operating characteristics as part of developing workable solutions and actively discussing their application with competent authorities.

In addition to airspace and regulation, interoperability and connectivity are also on the list of industry challenges. Volocopter addresses this by providing an integrated solution where information coming from existing surveillance systems and a combination of data providers can be processed and placed into a sensible picture, which reliably provides information to the pilot. This requires an aviation-grade connectivity service in the urban environment. We are developing a digital backbone for the UAM ecosystem, VoloIQ, to bridge this gap in connectivity while preparing for supporting technologies like 5G.

UAM is a technological revolution, a regulatory challenge and a unique opportunity for growth. Within the current framework, UAM operations can launch, but for their successful development, adjusted and new regulations and standards will play a pivotal role. Aviation regulators around the globe have heeded the call and are addressing these needs. In Europe, EASA and the European Commission are developing the necessary legal framework to safely integrate UAM to European airspace. Volocopter values the ongoing regulatory development and supports it both in Europe and globally by open communication and dialogues with regulators and the industry. We believe that to truly bring UAM to life, rulemaking and technology need to work hand in hand as pioneers on this frontier. We also continuously emphasise the importance of harmonising standardisation activities for the UAM industry, not only in Europe, but also as a common approach towards its implementation globally.

These are the main challenges that UAM will need to address. There are more, and new ones will arise, as we create this new form of mobility – as is with every industry. UAM is not only about new aircraft but about new concepts and solutions in various aviation domains. Volocopter is aware of and pioneering that, while partnering with experts in regulation, air traffic management, infrastructure, airports, logistics, unmanned aircraft system traffic management, and digital solutions to bring urban air mobility to life. Furthermore, we believe that making progress day by day, hand in hand with the regulators, local authorities, stakeholders and the industry is the only effective way to enable UAM to take off and scale up all around the world. The aim of enhancing mobility in cities can only be achieved if we work and think globally. What can be seen as a challenge, is also a great opportunity for change.
Yannick Combet, Programme Manager of the Stratobus™ project, describes the technologies, missions and capabilities of the High Altitude Platform System under development by Thales Alenia Space France.

“Stratobus is able to provide regional coverage at a very high level, high resolution”
Project Stratobus, developed by Thales Alenia Space France, is an autonomous stratospheric system, High Altitude Platform System (HAPS) which includes the vehicle itself, its payload and the ground infrastructure. It is powered by solar energy and can withstand its steady-state position in the stratosphere for up to one year, autonomously, providing a geostationary platform for multi-mission purposes.

Stratobus is a 140m long, 32m diameter airship positioned at an altitude 18-20km in the lower layer of the stratosphere, where the winds are moderate and air density is still sufficient to allow buoyancy. The Stratobus platform consists of a flexible envelope maintained in shape by helium in overpressure. Its total weight is around 9,000kg including a payload of over 250kg. These characteristics mean that it can reach altitudes around 20km and thus enjoy a visibility horizon of 500km.

The platform and its on-board solar energy allow it to counter winds of the order of 25 m/s and thus remain stationary over a point or area of interest with high availability. It is the only platform offering the ability to perform long-duration missions. It needs to come down to Earth only once a year for maintenance and to top up its helium.

WHY STRATOSPHERIC?

An operating altitude of 20km is a good compromise between taking advantage of the relatively weak winds and offering enough air density to ensure buoyancy. In addition, at this altitude the airship is still relatively close to the Earth: above air traffic, but at a height that provides very-high-resolution regional coverage.

STRATOBUS MISSIONS

Stationed at the edge of the stratosphere, about 20km above sea level, just above air traffic, but much closer to the Earth than a satellite, Stratobus is able to provide regional coverage at a very high level, high resolution. The airship can perform many missions, from precision surveillance of a given area or control of our environment, to telecommunications and navigation operations. It is intended for many applications such as surveillance of borders, oil operations and maritime piracy, vessel identification, air quality measurement, GSM network reinforcement during exceptional events and improved GPS systems in heavy traffic areas. As part of commercial telecommunications missions, Stratobus complements the global telecommunications ecosystem by offering fixed and mobile connectivity solutions in addition to those provided by terrestrial or satellite networks.

Operational costs are low and its ecological footprint based on a hydrocarbon-free concept, is minimal.

STRATOBUS KEY TECHNOLOGIES

Previous attempts at developing a permanent stratospheric high-capacity airship have faced technological or operations issues.

The Stratobus airship incorporates many technological innovations. The keys are mass and energy managements. Its 1000 m² solar generator and its high-energy density batteries are able to provide a large energy reserve for the airship, day or night, maximising solar energy while minimising the mass and surface area of the envelope.

In order to capture a maximum of solar flux, the balloon rotates around its main axis allowing it to position its solar generator facing the sun at any time of the day and in any season. Another key element is the design of the envelope itself. This has to take into account the structure of the airship and the sealing within a very low surface mass.

STRATOBUS TIMESCALES

A structuring co-engineering phase for the project started in 2016 at the Cannes site with Thales Alenia Space and its partners.

The development was split into two phases. The first phase was devoted to the preliminary study of the platform and technological demonstrations. The second phase related to the development of the system solution, including the platform, its ground segment and the missions.

During Phase 1, the analyses and preliminary design were correlated with numerous mock-ups. More than 3,500 physical tests have been carried out, from the basic component to the small-scale demonstrator to make sure that numerical models correlate to reality. All the technologies have been tested and for many in a representative environment. Phase 1 was closed in 2020 and the consortium concluded that the Stratobus concept was feasible with the technologies mastered.

Phase 2 was initiated in 2019 with, initially, a study phase of missions and operational concepts.

An operational demonstration stage is planned for 2024 to 2025 on the basis of small-scale models (60-meters long) called MVP for Minimum Viable Product. These demonstration phases are expected to take place on the Canary Islands. As soon as the stratospheric demonstration on a reduced scale is completed, the first full-scale operational model will be built and tested. The overall schedule depends on the financial scheme that is a permanent challenge for such a monumental development. In the meantime, Thales Alenia Space has started exclusive negotiations with the South of France region to define all the procedures regarding the facility that will produce the flight models.
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“WE NEED TO FOCUS ON DETECT-AND-AVOID AND COMMUNICATIONS”

The world of unmanned air systems is changing rapidly as they become more capable, complex and numerous – the future is now looking different from what was imagined just a few years ago, reports Bruno Boucher, Senior Vice-President, Airworthiness & Certifications at Nordic Unmanned.
All new airspace users present their own particular challenges for air traffic management (ATM) organisations. One of the most complex of all will be long-range unmanned air systems (UAS) operations, where many different platforms with widely contrasting configurations will be flying a variety of autonomous and semi-autonomous missions in both controlled and uncontrolled airspace.

The good news is that by the time regulations, technologies and standards arrive to support these operations at scale – probably around 2024 – many air navigation service providers (ANSPs) will have had years of experience managing long-range UAS operations developed to be compatible with existing ATM systems and procedures.

One of Europe’s largest UAS operators is Norway’s Nordic Unmanned, which provides a wide range of operations from fishery inspection and environmental monitoring in the North Sea to more local UAS missions such as rail network infrastructure monitoring and LiDAR-scanning and photogrammetry. The company operates from several locations in Europe and beyond – its contract with the European Maritime Safety Agency (EMSA) focuses on emission monitoring with the CAMCOPTER® S-100, and lightweight UAS support to operations from 10 other vessels in various EU countries with a 24/7 readiness.

For its maritime support missions flying in controlled airspace, the company identifies the safety margins of the drone and then works with the relevant ANSP to define restricted airspace areas which are then reserved for its operation, according to Bruno Boucher, Senior Vice-President, Airworthiness & Certifications at Nordic Unmanned.

“When we take off and land we inform them and are in constant communication with ATC,” Boucher says. “We have VHF radio like any other aircraft and our own VHF frequency in case there are search and rescue operations taking place nearby. This means helicopters from different countries know how to reach us and this allows us to stay clear of any potentially conflicting traffic.”

The company’s UAS platforms are also equipped with ADS-B and Mode S transponders for all-round conspicuity.

“But it’s not very practical because it restricts the volume of traffic,” Boucher adds. “We are working with the relevant authorities on introducing new detect-and-avoid technologies and procedures which will allow us to have a more coordinated approach with manned aviation, so we can all fly in the same airspace following the same rules and carrying similar traffic collision avoidance system (TCAS) devices.”

The current procedure of reserving airspace around the UAS will change once active detect-and-avoid technologies become available. Then the challenge will be to co-exist with general aviation aircraft which do not carry TCAS devices – non-cooperative traffic may need to have their own reserved airspace at some stage in the future, according to the company’s vision of the future.

“We will need to follow the framework of the UAS traffic management system (UTM),” says Boucher. “First, you need to be visible – that’s probably the easiest thing to do. Then we will need to implement some airspace management systems to manage the lower airspace; there will be a need for a new communication network for non-cooperative aircraft. Today communication is with the pilot, but we need to move to a higher level to communicate directly with the aircraft and for that we will need standards, so the autopilot understands the commands in a similar way. For that you need standardisation of autopilots and communications.”

Around an airport and over land 4G and 5G communications will work, but in a maritime environment or over landmasses where network coverage is sparse, other forms of communication will be needed. Bruno Boucher is concerned that this is not a priority area for regulators at the moment, which means industry will have to take a more proactive approach to developing new regulations – not merely waiting for them to emerge, but to put forward proposals now so the priorities can be identified.
In ATM we connect people, places and skies, making everything work. We partner with our clients building the future together.
“We have UTM implemented around airports, which is great, because this is where you have the most interaction between manned and unmanned aircraft. But once you leave this five- or eight-kilometre radius, it’s kind of a no-man’s-land and how should you manage this? The economics should also drive the priorities. For a number of years we had a vision of drones delivering goods within a city but now this dream is over because so many alternatives now exist. A bicycle is probably faster than a drone and it’s cheaper.”

Boucher believes the future priorities of drone technology research and regulation will therefore be very different from those envisaged just a few years ago, where the focus was on supporting small drone operations in urban areas. Larger drones flying longer-range missions will need both active and passive de-icing technologies. Electricity is no longer the only fuel under consideration – hydrogen alternatives will need to be researched and matured. The key will be to understand which systems can be relied on to work continuously, seven days a week and twenty-four hours a day, in other words building resilience and maturity into the sector to the same level which the civil aviation industry has come to expect.

“The key will be to understand which systems can be relied on to work continuously”

“Our customers are also maturing,” he says. “They no longer ask for a particular type of drone for the job, they want the service the drone offers – image monitoring at a certain distance and over a certain time. So the focus will be more on the sensors and how we integrate them; how we get the data, the quality of the data and how that data is stored. For some customers who want surveys we can now offer 3D maps and analysis looking for cracks and variations in the structure. We have the data, we can do the analysis today, but maybe we don’t see anything so we will have to wait a year to do another survey and compare the results.”

The main priority for Bruno Boucher is the further integration of manned and unmanned aviation, which means a robust and precise and detect-and-avoid capability along with a communication infrastructure to enable further control and further exchanges. “We would be really happy to see more regulation and new standards to define those exchanges,” he says.
WHERE THE WORLD OF MOTORWAYS AND AIRWAYS MEET

By Anton Zajac, the co-founder of Klein Vision, whose prototype AirCar completed a 35-minute flight between international airports in Nitra and Bratislava, Slovakia at the end of June 2021.

How do you see AirCar transforming the future of personal air transport?

The future of transport is hidden in alternatives, and must take into account efficiency, weight reduction, ability to integrate new technologies, reduction of carbon footprint and the shift to sustainability. One of the alternatives is the flying car. Our idea lies in the transformation and use of both car and aircraft modes, the so-called dual-mode transportation vehicle. The flying car segment does not require additional costs for new infrastructure development. From a user point of view, the flying car needs to be understood in the context of technological development, which will integrate more and more into the use of airspace, increasing security through the use of autonomous systems. The past but also the future has always been connected with the feeling of freedom, which is an important element of the human psyche. Paradoxically, the cars that once brought people freedom are losing us freedom today – current trends in the automotive industry to increase engine power are restricted by existing speed limits (130 km/h limit), so the trend to increase speed appears to be illogical. On the contrary, in the aviation sector, performance can be transformed into speed with virtually no limitations. A fundamental dimension in individual transport can bring new technologies, especially in the field of integration of autonomous systems, artificial intelligence and global planning. It sounds like science-fiction but it’s coming in the near future.

What are the key programme milestones for the future – certification for commercial use and availability for purchase? When will we see the first flight of a four-seater, amphibious, twin-engined version?

In terms of milestone achievements, the crucial part was to complete all experimental phases to verify the basic aerodynamic concept, flight characteristics of the specified geometry and usability as a car. For this purpose a BMW KT1600 motorcycle engine was installed onto the framework of P1, which does not represent the final power plant solution. The advantage of the BMW engine was that the gearbox allowed us to test both modes. In the AirCar P2 development, significant emphasis is being placed on the installation of the ADEPT power plant. The ADEPT engine has been designed from the beginning as an aircraft engine and has double the power of the BMW. It’s a modern, six-cylinder engine with a fully digital electronic control unit; it is liquid cooled, located in the central part of the fuselage and is a feasible candidate to be certified and comply with strict automotive emission norms. Another difference between P1 and P2 is the use of a full carbon monocoque. Prototype 2 gives us the base for opening the certification processes of car and aircraft and verification of technology that allows cost-effective small series production with the reduction of overall weight compared to P1.

As far as certification and commercial use are concerned, there are two possible routes for commercialisation: one is
the strategy of selling kits after finishing the development phase of P2, which is still in the experimental category. Second strategy is to proceed with a more complex certification process of the Normal category according to CS23 certification specifications. In the case of obtaining sufficient funds, we consider the second strategy to be more optimal.

Looking at modification, currently more than 100 companies deal with the research and development of the classical flying cars concept approach based on dual modes, as well as additional conceptual variations such as a virtual take-off and landing (VTOL)/drones. This environment is becoming very dynamic; PAL-V has already had the first commercial success in this market with its concept based on the gyroplane. Our main argument is based on dual mode’s functionality, where one mode represents a form that not only evokes but also fully represents parameters identical to the sports car category, and the other mode is in the form of an aircraft; here AirCar achieves flight parameters comparable to most general aviation (GA) aircraft. We think this is one of the project’s biggest advantages. The AirCar concept is based on a lift body fuselage, through a unique transformation cycle, modifiable tail parts and folding wing mechanism being moved into the internal structure of the main body. This represents the basic construction framework from which additional variants will arise. AirCar spatial arrangements allowed us to develop unique patent-protected versions such as twin-engine, amphibious, three- and four-seat versions. Future versions are currently in the stage of spatial analysis. Klein Vision has decided on a two-seater version as an initial development phase, which showcases the attributes and uniqueness of a new means of transport.

How do you see the market for AirCar developing in Europe and globally?

We think that the success of the flying car segment will depend on several factors, such as the degree of the development and character of the ground infrastructure, the size of the country and its geographical parameters, airspace organisation, aviation infrastructure levels, social and hierarchical organisation of the country and its cultural and technical maturity. From this point of view, we think that the USA and EU markets are closest to allowing the possible integration of flying cars. There might be great potential in countries such as China that are dynamic and accelerating in the GA area. The potential is hidden wherever large areas without existing or underdeveloped ground infrastructure are available: Australia, Saudi Arabia, Russia, India. Another area that could be changed is the air taxi service. This service can be transferred directly from the air to the street and can connect procedures that are common in the ground taxi service with the high-speed travel and increased comfort within a radius of up to 1000 km. This could be possible with the three- and four-seat versions, or the amphibious version in the case of island states.

What would be a typical route, flight trajectory (range, height, instrument flight rules/visual flight rules (IFR/VFR)?

In effectively managed countries, legislation and rules follow modern ideas and technologies. The flying car will follow the current situation and trends that are expected in general aviation. The boundaries between IFR and VFR flights depend
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We think that the USA and EU markets are closest to allowing the possible integration of flying cars.

In further development, the focus will be placed on the application of new technologies and the development of avionics for flights under IFR conditions.

Have you had conversations yet with airports and air traffic control (ATC) about future operations?

We have participated for many years in conferences and discussion panels which deal with the issue of new means of transport in the individual transport sector. Twenty years ago, we took part in the ICAS conference in Manchester where the organisers had a problem incorporating this issue into the structure. Today, the topic of flying cars is no longer unusual and has its audience. The idea of a flying car does not need any special rules regarding flying and moving around the airport, the only situation that needs to be addressed is exiting international airports through the corridor and connecting to the current ground infrastructure.

What kind of avionics are on board – a standard general aviation fitment?

In P2, the installation of Garmin G3X avionics is planned. Currently, the experimental P1 is equipped with standard analogue instruments, aerometric probes, flight recorders and a variety of digital devices used to evaluate and indicate the transformation and engine parameters.

What are the limitations of use – weather conditions, night flights, loadings?

In the first stages, emphasis was placed on confirming the concept functionality and verifying an atypical aerodynamic solution. In further development, the focus will be placed on the application of new technologies and the development of avionics for flights under IFR conditions. The AirCar two-seater version will have a payload up to 300kg and will be equipped with a rescue parachute system as standard. However, let us not forget that adverse weather conditions for inexperienced pilots without IFR qualification can be overcome in car mode.

According to the legislative process is based upon the existing environment. The Slovak Aviation Authority was very helpful and searched for a solution together with us. P1 was implemented according to national rules in the experimental category under the Slovak Aviation Authority. For Prototype 1 construction took place under the supervision of the CAA and the methodology of flight tests was determined and a special certificate of airworthiness was issued. These procedures will also be applied when building the P2. After those stages, we should have sufficient knowledge to open certification processes with the EU Aviation Safety Agency (EASA). An ideal situation could be the establishment of a flying car legislative framework. This would also be the most natural, as it represents a very new and specific segment, which has its own peculiarities.
How has ENAIRE adapted its management to the decrease in air traffic?

We must all adapt efficiently to potential traffic fluctuations. We have to be flexible and be capable of reacting quickly to any contingencies. The recent situation confirmed the trend that ENAIRE was already working on to increase the scalability of its systems and better adapt to the changing demand. ENAIRE has had to readjust its goals, and the recovery from the crisis is the most important challenge facing the company and the aviation sector.

Within the EUROCONTROL network, Spain is leading the way in the recovery of flights, and we trust that this trend will continue. This summer, ENAIRE managed traffic volumes whose values were very close to the 2019 benchmark, with excellent service quality and punctuality figures.

What stands out from this historic period?

Of the 38 countries in EUROCONTROL, Spain, through ENAIRE, is the one that is lowering its route charges the most in 2021, around 8% below the average charge.

The industry has been able to deal with this crisis by containing costs and, in our case, lowering air navigation charges to facilitate the sustainability of the system and to help airlines with their operations and recovery.

And now, as air traffic recovers, ENAIRE is in a position to be fully operational following the foreseeable rapid increase in traffic, while upholding our standards, especially in terms of operational safety.

What plans does your company have to grow internationally?

We are working to create the subsidiary ENAIRE Global Services (EGS), which requires approval from the Council of Ministers.

EGS will be a key instrument for ENAIRE’s internationalisation and for expanding beyond our domestic role and becoming a global service operator. It will also be essential to our survival.

What plans do you have for satellite surveillance?

We recently presented STARTICAL, an initiative from ENAIRE and Indra to provide satellite communications and surveillance services, which will have similar performance to land-based services and allow for significant growth in operations in remote and ocean areas where it is impossible to install land-based surveillance systems, and where the separation between aircraft has to be increased, thus reducing capacity.

How is ENAIRE evolving its air traffic control system?

The current trend is towards digitisation and sharing information with artificial intelligence and Big Data. This will make it possible to automate and optimise the tasks of pilots and controllers. Interconnections between land and air systems will streamline pilot-controller communications, minimising risks. At ENAIRE, digitisation and satellite services are now a reality.

Future versions of advanced automated air traffic control systems, such as iTEC, developed jointly by European air navigation managers ENAIRE, DFS, NATS, LVNL, PANSA, Oro Navigacija and AVINOR, with Indra as a technology partner, are phasing in artificial intelligence and improvements in man-machine interface processes.

ENAIRE is also developing an entire environment of specific ATFCM applications and procedures to improve air traffic management.
INTEGRATING SPACE LAUNCHES WITHIN THE INTERNATIONAL AIRSPACE ECOSYSTEM

Luke Winfield, Operations Manager at Spaceport Cornwall, outlines the challenges involved in integrating spaceflight operations within international aviation networks.
Space technology has revolutionised the way we live our lives. The evidence is all around us, although more obvious in some ways than others. Day to day it helps us keep in touch with family and friends, predict the weather, find our nearest ride-share, make card payments and access a repository of the world’s knowledge via the internet. Satellites keep an eye on our fragile Earth allowing us to study global warming, monitor disasters, identify diseased crops and improve agricultural efficiency to feed our growing population. Strategically and tactically, our militaries rely on navigation, secure communication and information services to keep us safe, much of which is derived from space-based data.

The changes are also hard to miss in the aviation industry. Inertial Reference Systems (an Apollo programme spin-off) and global navigation satellite systems (GNSS) allow us to cross oceans, navigate mountains and deliver precise-approach and autoland capabilities with unprecedented accuracy. SATCOM provides aircrew with access to a medical professional on every flight, immediate weather updates, Controller-Pilot Data Link Communications (CPDLC) and ADS-B surveillance. When things go awry, satellites receive 406Mhz emergency beacons to locate aircraft in distress. Airspace management relies on these modernising factors to deliver the same reliable service to a more congested European sky.

Policymakers are increasingly aware of the importance of space data to the functioning of modern society and are seeking to deliver higher assurance of access to it. The UK has committed to growing the domestic space sector from 5% to 10% of the global market by 2030, alongside the LaunchUK programme to develop national capabilities for space launch. Spaceport Cornwall is a frontrunner, with the site due to deliver horizontal launch from Summer 2022. However, this presents an interesting challenge to integrate launch operators, among other new entrants, with the existing airspace management strategies. The solution to this challenge spans far beyond the UK and will require an international effort to deliver mutual benefits to Europe as a whole.

**SPACEPORT DEVELOPMENTS**

Spaceport Cornwall has all the makings of a world-class spaceport. Located at Cornwall Airport Newquay, its proximity to the coast, low population density, uncongested airspace, long runway, developed air traffic services and ease of connection to population centres all work in its favour. The site is one of several designated as UK spaceport developments. Unlike a traditional vertical site, Spaceport Cornwall is developing services and infrastructure to support the test, integration, take-off and return of horizontally deployed launch systems. This distinction also represents a fundamental difference in how the airspace is to be used.

For a vertical spaceport, the launch will always take place from the launch pad, and so the trajectory remains fixed, varying only with azimuth (direction of launch). The affected airspace, land and marine areas referred to as the “range” therefore also remain fixed. On the other hand, horizontal sites such as Spaceport Cornwall offer a gateway to the skies, with the launch operators themselves designating the airspace required for their particular mission, and provide any services required as a result. Services required will vary from operator to operator; for some, it will be as simple as a departure NOTAM, imposition of a safety clear zone and emergency services on standby. For others, it may extend to include range monitoring, notification, coordination, tracking, Danger Area Crossing Services (DACS), telemetry reception, mission control and beyond.

**THE CHALLENGE AHEAD**

It’s unfortunate that the global spaceflight industry does not benefit from an overarching organisation such as ICAO to issue internationally agreed standards and practices. One does not need to look very far to notice the effects: the edge of space is defined as either 50 kilometres, 50 miles, 62 miles, 100 kilometres or 122 miles, depending on who you ask! This begs the question: until what altitude does sovereign airspace apply, as granted by the Paris Convention of 1919?

Launch from the USA, Russia, Japan, China, India, French Guiana or other space-faring states have one or perhaps two Flight Information Regions (FIRs) to contend with; launch from Europe must consider many more, due to the close
The complexity of achieving a safe, efficient and compliant launch range in European airspace is not to be underestimated; however it can be achieved with solid international cooperation. The UK Space Agency is hard at work to achieve this, recently announcing Memoranda of Understanding (MoU) with Norway, Jan Mayen and Greenland regarding the use of Exclusive Economic Zones (EEZ) and sovereign airspace for stage return, fairing return and overflight. In addition to national space agencies, EUROCONTROL’s Network Manager (NM) is also a key player in the coordination of international Air Traffic Management (ATM), maintaining regular contact with Spaceport Cornwall since the planning stage.

A key consideration in the selection of a launch range, as mentioned earlier, is the impact on other airspace users and the ability to integrate with the network. With recent trials undertaken to remove the Organised Track Structure in the North Atlantic and implement free route airspace, this may pose a challenge for early identification and avoidance of high-traffic areas. This particularly affects Spaceport Cornwall and other UK launch sites, with the North Atlantic both an excellent asset in accessing many desirable orbits, and a detriment in the complexity of ATM and integration.

While the “flexible range” concept of horizontal sites means the selection of the launch range is not a spaceport-controlled parameter, the reduction of adverse impacts of launches from Spaceport Cornwall is of utmost importance. Spaceport Cornwall is striving to be the most sustainable launch site on the planet, and this goes further than just a tagline; it means championing the successful integration of traditional airspace users with spaceflight technology to the maximum extent possible.

New challenges often demand new solutions, and it’s clear the burgeoning development in the sector cannot be regulated in the same way as commercial air traffic. For regulators, Air Navigation Service Providers (ANSPs) and network managers, being receptive to change is necessary to be ready for the future of aerospace technology. But we must avoid trying to reinvent the wheel. The United States, for example, has decades of experience in this area and is beginning to integrate space activities with the National Airspace System (NAS) in a more streamlined fashion. Lessons learned must not be lost on European stakeholders, just because there are regional differences.

Perhaps a key enabling factor in the development of sustainable space launch will be the integration of Air Traffic Management with Space Traffic Management (ATM/STM). Initiatives such as the Single European Sky ATM Research (SESAR) Joint Undertaking’s ECHO Project, funded by the European Union’s Horizon 2020 programme, will certainly help to deliver a better industry-wide understanding of what’s coming in the future of aviation, and how to be prepared for it.

It’s an undeniable truth that space technology improves life here on Earth. Our citizens, industries and militaries rely on satellite data for many functions, and a modern world without it would be stranded. As European states such as the UK progress in developing spaceports to secure access to orbit, new use-cases for upper airspace will soon begin to materialise. Incorporating these activities within the existing European airspace construct is a two-sided coin. On one side, integrating future airspace users into the current ecosystem and defining the cross-over between the ATM/STM; on the other, streamlining national processes within an international environment. International coordination is paramount to minimising the impact on existing airspace users and realising the mutual benefits of reliable access to space for Europe as a whole.

FOR THE STARS TO ALIGN

The future of European spaceflight seems bright. With multiple spaceports in the UK funded, the National Space Strategy published in September international agreements maturing and Spaceport Cornwall planning a pathfinder launch in Summer 2022, there’s a lot to be excited about. However, there is also a lot of work to do to integrate spaceflight operations with international aviation networks. That’s no easy task, considering each new entrant will have its own concept of operations for using the airspace, from the sea to the stars. Examples of such use cases include captive-carry launcher systems, balloon launch, vertical systems, reusable systems (launch and return), hypersonic point-to-point travel, High Altitude Platform Systems (HAPS), and orbital and sub-orbital human spaceflight. Each use case has differing impacts on other airspace users; these somehow need to be met with a structured approach to managing and integrating the activities.

“...it can be achieved with solid international cooperation...”

2 https://nats.aero/blog/2021/03/nats-records-first-day-with-zero-westbound-north-atlantic-tracks/
FOR BOEING, ENVIRONMENTAL CHALLENGES ARE LINKED TO WIDER ISSUES OF SOCIETAL ACCEPTANCE

In July 2021 Boeing published its first sustainability report¹, outlining not just its strategy for reducing aviation net carbon emissions to zero by 2050 but also demonstrating how the company is evolving to take account of society’s changing needs for more inclusivity and diversity. **Chris Raymond**, Chief Sustainability Officer at Boeing, reports.

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¹ https://www.boeing.com/principles/sustainability/annual-report/index.page
“Sustainability” – it is a word that is often used, with several meanings and even more interpretations.

For many organisations, environmental responsibility is not a stand-alone performance measure, it is part of a range of activities which, holistically, are integrated into new ways of thinking about corporate responsibility.

“We view sustainability as an integral part of the full environmental, social and governance picture,” says Chris Raymond, Chief Sustainability Officer at Boeing. “For us, this means addressing an umbrella of social and environmental activities – from how we treat our workforce to improving diversity; from how we govern the company to how our board of directors interacts with the environmental challenge. Our CEO Dave Calhoun is passionate about this topic and wanted us to be clear about what form sustainable aerospace is going to take. We’ve spent some time talking about this topic inside the company and we decided we wanted to show the work we are doing in four key areas: people, products, services & technologies and operations – our own operations and the work we do in our communities.”

“This report has been written to demonstrate the progress we have made but also to be sober about the work that we have to do,” says Brian Moran, Vice-President - Global Sustainability Policy & Partnerships at Boeing. “We wanted to demonstrate a blend of technological progress and the social dimension of aerospace - the 87 million jobs that are generated and the four percent of global domestic product (GDP) that’s associated with the industry. The global Green growth agenda, especially as we recover from the pandemic, is an integral part of this.”

In Europe, damaging weather events over the summer, the launch of the European Union’s Green Deal and the publication in August of the latest Intergovernmental Panel on Climate Change (IPCC) Report on global warming have all propelled environmental concerns to the top of government agendas. As it seeks to build a lasting recovery, the continent’s aviation sector has come under increasing pressure to change the way it flies – using current technologies more efficiently and, in parallel, developing new, cleaner propulsion systems.

Boeing has committed to have all its airliners certified to fly on 100% sustainable aviation fuels by 2030. The company began working with airlines, engine manufacturers and others to conduct biofuel test flights in 2008 and gained approval for their commercial use in 2011. In 2018 the company carried out the world’s first commercial airplane flight using 100% sustainable fuels as part of its ecoDemonstrator programme. In August 2021 Boeing launched the eighth version of this programme with Alaska Airlines, helping the company mature technologies and procedures that can improve efficiency and safety or reduce noise.

While the transition to new energies, such as hydrogen, electric or sustainable aviation fuels, is an important part of the ecoDemonstrator programme, Boeing is also targeting major advances in structures and manufacturing techniques, using new digital design and management systems which have shown potential 75% improvements in quality along with a significant reduction in assembly times.

While engine manufacturers do not need convincing about the importance of evolving technologies from current designs, the company is also putting pressure on its supply chain to find greener material alternatives and processes and examining new ways the environmental footprint of an aircraft can be better managed throughout its life-cycle. Around 90% of a current airliner, by weight, can be recycled and Boeing has pioneered new techniques with partners to recycle carbon fibres. Before an aeroplane is built, while it is in the conceptual stage, the company develops a sustainability life-cycle analysis to look downstream thirty years from now to when it is retired, taking in the parts it will need from the supply chain to where raw materials will be mined.

The road towards aviation decarbonisation is a complex one, involving many stakeholders working together towards a common goal. Some of the key elements of this are the fleet renewal programmes – with every new generation of airliners improving fuel burn by 20% to 25% – and the new operational efficiencies which airlines themselves are introducing.

So the key issue facing Boeing and all other aviation stakeholders is: how realistic is the prospect of aviation becoming a net zero-carbon emitting industry by 2050?

“In Boeing’s view the role that sustainable aviation fuels will play in this is vital and I think the government’s role to encourage, enable, incentivise is very important. I know in Europe the Refuel EU Aviation programme is being rolled out and is aimed at doing exactly that,” says Chris Raymond. “In the USA there’s a package of proposed legislation called the Sustainable Skies Act, which is taking a different approach but to the same end.”
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“I also think that the pressures on the oil and gas industry, on the automotive industry, the agricultural and municipal waste industries are bringing together an interesting set of players and collaborations that I am hopeful will let us scale up sustainable aviation fuel production. I don’t think there’s a one-size-fits-all, there can be different solutions on different continents. I also think our industry should get some credit for recognising the action we are taking on carbon offsets now as we collectively work to scale up sustainable aviation fuels (SAF) and deploy new technologies”, says Chris Raymond.

While Boeing is focused on SAF as the most realistic solution to decarbonise aviation over the next 20 – 30 years, it also has experience in hydrogen and electronic propulsion and continues to invest in these areas, given their potential longer term in the shorter-haul market segment with smaller payloads. Boeing is developing with Wisk an all-electric, autonomous passenger carrying vehicle called Cora, to understand what it takes to design, certify and integrate into airspace operations a new type of aircraft. This means looking at the infrastructure challenges, the business cases and certification issues. It has launched an urban air mobility air traffic management joint venture with Smart Cognition to figure out how these passenger-carrying electric vehicles can be safely integrated in low level airspace. For Boeing, ATM is a key component in building a more sustainable, digital aviation future.

“According to EUROCONTROL, between 8-10% of additional efficiency improvements can be gained by even more precise flying so there’s still some room to go,” says Brian Moran. “Aeroplanes are now so digitally enabled with features like required navigational performance (RNP) and continuous descent approach capabilities that there’s a lot of technology in the aeroplane which could be unlocked if ground systems globally were ready for it. I think the investments that air navigation service providers are making here, so the ground can catch up with the air, is one opportunity.”

Boeing has invested in its own digital analytics lab in Frankfurt, Germany where it studies among others advanced cockpit technologies that can be used to make air traffic management and flight operations more efficient. For Boeing, this means looking for example at how airlines can fly at different altitudes and more closely together.

**STEPS ALONG THE WAYS TO DECARBONISING AVIATION**

Boeing’s latest sustainability report highlights the programmes underway internally and with partners to reduce its carbon footprint. It achieved net-zero carbon emissions at manufacturing and worksites and in business travel in 2020 by expanding conservation and renewable energy use, while securing responsible offsets for the remaining greenhouse gas emissions. Since 2008, Boeing has voluntarily and transparently reported greenhouse gas emissions from its operations in annual CDP (formerly Carbon Disclosure Project) disclosures. In 2020, CDP awarded Boeing a leadership-level grade of A -Boeing Sustainability Report.

Boeing’s greenhouse gas reduction strategy is managed within the Global Enterprise Sustainability organisation. The management team tracks performance, procures energy, and initiates energy and emissions reduction projects across the company. This organisation sets strategic goals for greenhouse gas emissions reduction and energy conservation and to play an active role in achieving those goals. Greenhouse gas emissions from operations are monitored on a monthly basis through the use of utility metering. The emissions factors for these energy sources are validated at least annually and updated when appropriate under the World Resources Institute GHG Protocol. The energy source data and emissions factors are audited as part of the third-party verification of the company’s annual CDP disclosure, which contains a wealth of information about our emissions, reduction efforts and governance.

Boeing has been partnering across the industry on concepts for advanced aircraft that can meet specific energy efficiency, environmental and operational goals in 2030 and beyond. For example, the Transonic Truss-Braced Wing (TTBW) concept, provides a 9% improvement in fuel burn when compared to a cantilevered wing of the same technology level.

Boeing uses a Flying Laboratory to Test Industry-Changing Technologies. Launched in 2010, Boeing’s ecoDemonstrator programme accelerates innovation by taking promising technologies out of the lab and testing them in the air to solve real-world challenges for airlines, passengers and the environment. In 2020 Boeing, in partnership with Etihad Airways, conducted two test flights using digital communications that simultaneously connected pilots, air traffic controllers and airline operations centres to enhance safety, optimise routing and reduce emissions. It also tested a timed-arrival management tool as part of an airspace efficiency project to further reduce emissions. The aircraft uses a blend of up to 50% sustainable aviation fuel on every ecoDemonstrator flight.
iTEC V3

The iTEC Alliance has launched iTEC V3, its new highly advanced ATM system. PANSA is the first ANSP to deploy the iTEC V3 system in its ATC Contingency Centre in Poznan, Poland. Developed by the world’s most advanced ANSPs and technology partner, Indra, it will enable the new architecture proposed by the Airspace Architecture Study (AAS) and will allow the development of new business models, such as Air Traffic Data Services Provision (ADSP). The iTEC V3 ATM system will use new technologies such as virtualisation, cloud computing and advanced automation to respond to the challenges of the future Digital European Sky in areas like resilience, scalability and sustainability.

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iNM

PANSA together with Indra and its partners design the next generation of EUROCONTROL Network Manager (NM) operational systems. The ten-year integrated Network Management (iNM) programme envisages by 2029 the incremental renewal of all the NM’s main operational systems, resulting in a new digital architecture that will harness the power of innovation and enable NM to deliver ever more integrated business services and products to its stakeholders.

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NaviHub

PANSA consolidates aviation R&D competences and resources by initiating and co-creating R&D Centre - NaviHub - a project which is comprised of a network of organisations, sites and equipment (Centre of Competence) as well as data, knowledge and laboratory for digital simulations (NaviLab), both at ATC Contingency Centre in Poznan, Poland, and test airfield (NaviSpot) in Kąkolewo, Poland.
Janusz Janiszewski,
PANSA CEO
& Chairman of the A6 Alliance
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REGULATORY PERSPECTIVES ON EMERGING HIGHER AIRSPACE USERS

Giovanni Di Antonio, High Altitude and Access to Space Operations Regulation Team Leader at the Italian Civil Aviation Authority (ENAC) and Chair of the EASA Higher Airspace Operations Task Force, looks at the innovative regulatory approaches underway to integrate a new community of high airspace users.
The last decade has seen an increase in emerging airspace users, boosted by technological innovation, looking to exploit new commercial opportunities from very low level to very high level. This includes drones and air taxis for Urban/Advanced Air Mobility, High Altitude Platform Systems (HAPS) for communication, surveillance and Earth observation, commercial space and suborbital vehicles for air-launching, experimentation and space tourism. Other new entrants are expected in the coming years, such as intercontinental point-to-point supersonic, hypersonic and suborbital aircraft, and re-entry-from-orbit vehicles.

To support this development, regulators are being called upon to rethink traditional paradigms and approaches to find new solutions according to Better Regulation principles, to allow a safe accommodation and integration of these new operations into the airspace without disproportionately affecting the current and future aviation sector.

While drone regulation is well underway in Europe, regulation for high altitude operations is still in its nascent phase – which may be an opportunity indeed – even if some States, like the UK, and partly Italy, have developed their national regulation in this domain having benefitted from the FAA experience in the US.

**HIGHER AIRSPACE OPERATIONS**

Higher Airspace Operations (HAO) include all those operations (HAPS, supersonic and hypersonic flights, suborbital flights, aero-launching and vertical launching into orbit, and re-entry from orbit) which are carried out in the higher airspace, namely above the flight levels where traditional aircraft are controlled today, but not yet in outer space. The higher airspace concept is currently under discussion: there is not a clear consensus at the moment on a definition, mainly because of the absence of a legal boundary between airspace, where states may exercise their sovereignty over their territory according to the Chicago Convention, and outer space that cannot be subject to national appropriation by claim of sovereignty according to the Outer Space Treaty.

To get around this obstacle in a pragmatic way, a functionalist approach to regulation may help by focusing on regulating the specific operation(s) rather than establishing different rules or legal regimes for different altitudes.

**EUROPEAN INITIATIVES: THE ECHO PROJECT AND EASA HAO TASK FORCE**

In 2020, in response to a European Commission request, EUROCONTROL started the ECHO project for developing the European HAO concept of operation, and EASA set up the HAO Task Force to carry out preparatory work for future HAO regulation. This regulation is expected to be based on the High-level Principles developed during the first European Higher Airspace Operations Symposium held in Brussels on 2 April 2019 taking into account Member States’ experience. Remarkably, among others, the High-level Principles need to “ensure the safe and orderly implementation of higher airspace operations using risk- and performance-based approaches to innovation and regulation when establishing the appropriate requirements for safety, security, contingency and resilience of operations for all phases of flight.”

The EASA HAO Task Force is composed of EASA, national aviation authorities of interested EASA Member States, and the European Defence Agency (EDA) to ensure civil-military coordination. The participation of the ECHO Programme Manager from EUROCONTROL as observer, ensures coordination with the ECHO Project. Its work programme extends to 2024 and foresees the development of a set of regulatory principles and assumptions, vehicles and operations categorisation, regulatory structure options, and an impact assessment that will lead to final recommendations on how the regulatory framework might be shaped.

**REGULATORY APPROACHES: OPERATION-CENTRIC VS FULL-CERTIFICATION**

Different approaches are needed for different situations. The modern operation-centric, risk-based and performance-based approaches could be used as possible alternatives to the traditional full-certification when possible and deemed appropriate. Whatever the approach, regulation should cover the risks posed by the operations to third parties on ground, in the air, in space, to people onboard, and critical infrastructure, while protecting the European States’ defence and strategic interests.

Following an operation-centric approach, it would be possible to issue one single operational authorisation to carry out one or more flights under the same scenario, vehicle configuration, infrastructure, conditions and limitations without the need to authorise every single element separately. The authorisation may be based upon the results of a holistic risk assessment that identifies a balanced set of technical and operational mitigating measures – including flightworthiness design provisions, if needed – to control all foreseeable hazards related to design, production, maintenance, operational procedures, personnel licences and training, infrastructure,

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1 The Task Force may also interface, as deemed appropriate, with other countries and international organisations and initiatives active in the HAO domain: first of all ICAO, but even JARUS and the European Group on Suborbital Flight Regulation (EGSFR)
“Whatever the approach, regulation should cover the risks posed by the operations to third parties and to people on board”

and so on, up to an acceptable low-risk level compliant with the level of safety set by the regulator. This approach would then be suitable for experimental or specific State or commercial operations.

By contrast, the traditional full-certification approach is based on a prescriptive regulation that allows operations only when the vehicle and any other element of the operation has obtained the relevant certification issued by a competent authority.

PERFORMANCE-BASED APPROACH TO OCCUPANTS’ SAFETY

Irrespective of the approach followed, flightworthiness requirements are needed to ensure vehicles integrity and occupants’ safety for human operations. They could be developed either in a prescriptive manner or by using a performance-based approach which is common today in general and unmanned aviation.

Prescriptive regulation contains detailed provisions and quantitative safety targets. Nevertheless, because the sector is in its nascent phase and there are very few reliability and occurrence data available, it might be not easy to set effective detailed requirements for different types of vehicles in a proportionate manner. Alternatively by developing performance-based requirements the regulator only sets qualitative safety objectives to be complied with by consensus standards developed by industry or standardisation bodies and approved by the authority that may better tailor to specific architectures, allowing innovative solutions.

REGULATORY STRUCTURES

We do not expect the same type of vehicle to adhere to different sets of rules for similar scenarios in different parts of Europe; rather, it might be desirable to have a unique risk-based regulation with common objective requirements to be met in different situations by using different technical and operational mitigating measures. This type of regulation could be built on two levels.

The first level might contain a common set of rules valid for all types of operation, such as Higher Airspace Traffic Management (HATM), air navigation services, air and space collision avoidance, interface with space traffic management (STM), organisations and safety management, occurrence reporting and investigation, etc.

The second level could be modular. Specific rules for different categories of vehicles and operations might cover aspects such as design, production, maintenance, operational procedures and personnel, and related supporting infrastructure on ground – such as spaceports – in the air and in space, with the aim to protect people on ground and occupants onboard.

In this framework, human and non-human operations which do not imply point-to-point passengers or goods’ transportation (HAPS, regional suborbital flight, aero-launching, vertical launching, re-entry), and experimental operations could follow a risk-based operation-centric approach as opposed to intercontinental point-to-point suborbital and hypersonic flights which could be regulated by a full-certification approach in the long term. These kind of options are going to be discussed by the EASA HAO Task Force in the coming months.

MAIN CHALLENGES

There are a number of challenges to be dealt within the HAO domain, namely: how to coordinate air law and space law; how to share responsibility between the EU and Member States; how to integrate the future HAO regulation with existing and under development drone regulation; how to regulate new services in the higher airspace and up to which altitude; how to set new rules of the air suitable for different vehicles’ performances; how to assure a fair and equitable access to higher airspace; how to set an appropriate level of safety for different vehicles and operations categories taking
into account the technology’s state-of-the-art, and how to set effective interfaces and coordination between ATM and STM, which is important to avoid collision with active space objects and space debris. Environmental issues shall have to be carefully considered as well by evaluating the impact both at the surface (e.g. at take-off and landing sites) and for the atmosphere (troposphere, mesosphere and thermosphere).

Special attention will have to be paid to those traditional space operations such as vertical launching and re-entry that fall in principle under national space laws. These operations are expected to be regulated for their transiting into the airspace and for sharing aviation infrastructure. One issue for HAO will be the degree of integration into the airspace in the medium and long term, in contrast to today’s segregation practice. Another will be whether the new HAO regulations should also deal with the safety of spaceflight occupants (e.g. in a re-entry flight), or if this aspect will remain under the remit of the States. In this respect, the clarification of the vehicle’s legal status (along with registration requirements) in the different phases of its operational life will be of particular importance, especially when it does not always behave as an aircraft or when it can be considered a space object, such as the Space Rider Re-entry Module.

Finally, to unlock operations, we will also have to tackle the issue of third-party liability and insurance, considering the potentially higher risk of HAO compared with traditional aviation, and their similarity with space operations; in this domain a conciliation between the aviation regime, that makes the operator liable, and space regime, that makes launching States liable, will be necessary.

All these challenges will require a coordinated and collaborative approach between aviation and space institutions, research bodies and industry in the coming years.

**MOVING FORWARD**

To ensure the future European HAO regulation is built on a solid foundation it will be of paramount importance to gather specific use-case information from States based on HAO experiences taking place in their territories in the near- and mid-term. At the same time, it will be essential to complete the European HAO concept of operations by the ECHO Project and the preparatory work for regulation by the EASA Task Force in order to eventually allow the formal EU legislative procedure to start within the next years. Moreover, the inherently global nature of HAO requires cooperation at international level, in particular with ICAO, to hopefully move – bottom-up – towards an increasingly consistent international framework able to support the necessary degree of interoperability.

Emerging users are emerging. An effective and flexible HAO regulation able to ensure a level playing field in terms of safety, security, equitable access to airspace and capability to accommodate or integrate present and future entrants without disproportionately affecting current aviation is then unavoidable. Unlocking HAO starting from today will foster innovation and support the growth of a new aerospace economy, allowing authorities to gain experience to continually improve the regulatory framework. To this end it will be essential that the European Union and national aviation authorities work together with space institutions and industry stakeholders in an increasingly coordinated manner, to exploit these opportunities in the coming years.

**Disclaimer**
The opinions expressed in this article are those of the author and do not necessarily reflect the view of the EASA HAO Task Force or that of its members.
Coflight Cloud Services (CCS) is a SWIM 4D trajectory service powered by Coflight new generation Flight Data Processing (FDP). Today, CCS became the first to publish its services in the SWIM registry with the conjunction of EUROCONTROL. This success milestone puts CCS firmly on track to achieving the goals of the Single European Sky (SES 2+) and Airspace Architecture study (AAS), the European initiative underlying this transformative service.

**WHAT MAKES CCS DIFFERENT?**

Based on an open, modular and interoperable architecture, CCS ensures interoperability between all ATM actors, allowing seamless exchange of digital information through SWIM and defragmenting ATC systems. In addition to its superior capabilities based on Coflight, the most advanced flight plan processing system in Europe, CCS offers a unique cost-sharing model and collaborative approach to ensure that the service is constantly improved. With this model, several ANSPs remotely use the same system to deliver FDP services, thus sharing investment and reducing operating costs. Finally, CCS customers are members of a Coflight User Group and in this capacity they help define future service evolutions through a collaborative process.

**EXPECTED BENEFITS**

CCS is expected to improve ATM security, resiliency and efficiency by empowering ANSPs with greater flexibility and helping to optimise use of airspace. It is one of the first systems in the critical ATM domain that can be deployed in a Cloud infrastructure, thus benefiting from gains in terms of administration, innovation and resource optimisation. Currently, CCS centralizes its Data Center in Paris and Rome and is able to provide services remotely to other European ACC. Thus, the system guarantees service continuity by doubling the location of the Virtual Center, ensuring an optimal solution for security and protection against cyber-attacks.

Thanks to the efforts and energy of the DSNA and ENAV teams, CCS is able to provide its customer skyguide with a set of ATM data processing services (flight plan, weather, etc.) based on the latest Cloud Computing technologies. This allows controllers to benefit from continuous innovation, with increased speed and reduced costs compared to traditional ATM infrastructures, without compromising the safety and security of the system. The scalability offered by Cloud Computing allows the services offered by CCS to be operated by new customers without having to suffer from heavy installations or deployments at their premises.

CCS aims to reduce environmental impact by improving trajectory prediction with the use of data shared by the ANSPs, allowing more flexible trajectory planning and free route thus limiting flight time and reducing CO₂ emissions. Coflight continuously computes a volume of trajectory prediction, and consequently offers opportunities for 4D trajectory optimisation. The reduction of the carbon footprint is also possible thanks to the consolidation of the systems offered by CCS.

**STATE OF PLAY AND NEXT STEPS**

Skyguide, the first customer and partner in the CCS project, signed the contract for the development and delivery of the first level of CCS service, Technical Integration, on July 1st, 2020. Implementation of the agile Safe method as well as successful international cooperation has enabled this first positive achievement in a relatively short time at the European level. The year 2021 gets off to a strong start for the DSNA, ENAV and skyguide teams. They have successfully completed the commissioning of the new version of Coflight at Paris ACC. The Step 2 started in January 2021 and will end in September 2022 with commissioning.

The main objective of this period will be the provision of two services for skyguide:

- **Extended “Technical Integration Service”** with new SWIM operations that will derive from the SESAR programme.
- **Initial “Validation Service”:** to provide skyguide with an initial dataset representative of the airspace and then to bring the initial service into operation. The initial validation service can then be used to update skyguide dataset and allow them to be autonomous in the configuration of CCS services.

**STEP 2**

Step 2 will also allow an operational impact assessment to be carried out, so that skyguide can improve the operational concept. Indeed, using CCS as an ADSP will have an operational impact on skyguide ATCOs. This assessment will support them to organise adequate training and/or implement technical mitigation.

Finally, this is an important period for DSNA, ENAV and skyguide to align continuously themselves around respective roadmaps, with the European landscape (SESAR, SWIM governance) and with the authority (states and NSA).

The CCS teams are already well on this way to ensure the deployment and the success of Step 2. The excellent collaboration between the DSNA, skyguide and ENAV should once again prove its worth in achieving this milestone.

https://coflight-cloud-services.com
OUR VISION OF HOW TO INTEGRATE NEW VEHICLES INTO THE AIR TRANSPORT SYSTEM

Eduardo Garcia Gonzalez, CANSO Manager European ATM Coordination and Safety, explores how a unique cross-industry collaboration is driving the development of an industry-first global vision and approach for managing new, emerging and future airspace users.

We are now entering a new, exciting era for aviation in which the speed of change and rate of innovation will be faster than they have been for decades. A wide range of vehicles are already – or soon will be – taking to the sky, including small drones, air taxis, new commercial aircraft designs, space flights, supersonic and ultra-long-haul flights, and we need to be ready for this.

The rise of new airspace users is exponential, and will continue to climb as new applications and requirements drive demand. Safely accommodating new airspace users into our sky, without congestion or increased delay, will require new ways of thinking and increased collaboration among the broader aviation community.
KVM IN AIR TRAFFIC CONTROL AND MANAGEMENT
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As a sector we need to act collectively in order to mobilise all the players in the community and help build our future complete air transport system together. Of course, this is easier said than done – but I am confident we are already making great progress.

In March, CANSO launched the Complete Air Traffic System (CATS) Global Council – a unique innovation forum which brings together leaders from more than 25 organisations across the manned and unmanned aviation industries. This includes air navigation service providers (ANSPs), UAS Traffic Management (UTM) service providers, aircraft manufacturers, drone operators and manufacturers, high-tech companies, airlines, airports, regulatory authorities, space agencies and research bodies.

FUTURE SKY VISION

The goals of this innovation forum are to drive the next era of aviation and forge a more adaptable, resilient industry; to explore, imagine and shape a shared vision for how our global skies can innovate and interoperate safely in the future, and to lead the way, enabling all aviation and aerospace players to learn, evolve and advance so that they are fit for this exciting future.

We are delighted to be able to count leaders from NASA, ICAO, IATA, ACI, Boeing, Airbus, Wing, Altitude Angel and across the ATM industry as members of our Council. We are grateful they are sharing their insight and honoured to be working together to create this industry-first common vision for the total traffic management for every airborne vehicle.

The CATS Global Council has made great progress already, and will be sharing the vision during the World ATM Congress 2021 in October.

The vision is being crafted with a collection of operating principles at its core. These principles address the future-facing features, behaviours and practices that are critical to achieve the fully integrated airspace system we aspire to.

These are as follows.

**Scalability**
Digitisation, location-independent operators and automated airspace management will ensure the entire sector can scale operations up or down according to user needs, hazardous events and user demand.

**Interoperability**
The cooperation and interconnectedness of diverse operators is essential for a fully integrated, harmonised sky.

**Adaptability**
The entire airspace system, from design to operation, is dynamic in nature. Such flexibility needs to be built-in to enable airspace infrastructure, management and users to adapt to diverse vehicle performance and growth of traffic.

**Sustainability**
Aviation will take a leading role in reducing emissions across the global transport network. The future airspace system will also require longevity to ensure that innovations are efficient, resourceful and future proof.

THE PATH AHEAD

The CATS Global Council does not plan to stop here and will continue working to develop a roadmap to achieve our shared vision that everyone will be able to rally around. We aim to finalise a first version of the roadmap by spring 2022.

In the meantime, we look forward to extending Council membership to include further parties that will support us in turning the vision into reality, and welcome organisations from across the industry who wish to join us.

Find out more at futureskyvision.com and help us champion a new future for our industry today.

“Safely accommodating new airspace users into our sky will require new ways of thinking and increased collaboration”
“ANSART is a synergy of the best practices we have learnt from software development strengthened by solid team expertise in aviation.”

Serge Miranovich, CEO, ANSART B.V.

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**Are you interested to know how we work?**

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For more information contact us at: info@ansart.nl
“WE NEED TO FIND THE RIGHT BALANCE BETWEEN MILITARY AND CIVIL NEEDS”

Major General Karsten Stoye starts work as Head of EUROCONTROL’s Civil-Military Coordination Division on 1 October at a time when civil aviation is under tremendous pressure as a result of the pandemic. What are your priorities as you take up this new function and what do you see as the key challenges for civil-military coordination going forward?

I would first like to say that I am very proud to be joining the EUROCONTROL team. I recognise and appreciate the outstanding work that the team delivers day in, day out, to make EUROCONTROL the premier Air Traffic Management organisation in the world. Over the coming months, I am looking forward meeting all of you, to learn and better understand your requirements, the challenges you face and your ideas about how to meet those challenges. As we all recover from the impacts of the COVID-19 pandemic, it is even more apparent that people and mission cannot be separated; they are integral to the delivery of the tasks that make aviation in Europe safer and more efficient, and minimise the environmental impact. As I join the team I hope to bring my extensive knowledge, broad experience, motivation and dedication to the mission.

That said, I would like to offer some initial thoughts, starting with three main topics that I consider to be a priority for successful civil-military cooperation (CMC).

Firstly, bringing Air Traffic Management (ATM) in line with the Future Architecture for Airspace Management. As Europe is moving towards an open architecture, capable of enabling a seamless, flexible and scalable provision of services, the digital European sky standards will play a critical role in supporting global interoperability and worldwide harmonisation. By showing compliance with a more performance-based regulatory framework, this will enable the implementation of innovative solutions like System-Wide Information Management (SWIM), which needs to treat military data with the required levels of confidentiality.

Secondly, another area which I believe needs more attention is the use of sovereign airspace by individual nations as we transition from peace to conflict in a crisis scenario in Europe. Clear and transparent procedures within the civil-military cooperative decision-making process, as well as a new mindset, will be required to achieve interoperability across the European Nations, the European Union (EU) and NATO, and a common understanding between civil and military entities. A good avenue for improvement could be the introduction of table top exercises for relevant stakeholders, and increased participation in NATO and EU exercises.

Finally, as far as the technical side is concerned, dual-use solutions will be the way to go. For the Single European Sky (SES) ATM Research (SESAR) venture, subsidies should be made available for military requirements, and civil-military security cooperation should be nurtured. Within the field of communications, navigation and surveillance (CNS), the
rationalisation and reutilisation of military capabilities, performance-based certifications, and the dual-use of civil-military equipment will be the vectors that lower the costs, and the impact for the military side. The military is keenly interested in a coherent civil-military CNS procurement process that is able to reduce costs, improve efficiency, enables automation and improves connectivity. I think we need to find the right balance between military and civil needs; military aviation should ensure similar levels of system performance, however, without any undue cost that would diverge defence funds to support civil cost reduction without any tangible national security benefits.

How can EUROCONTROL further enhance civil-military cooperation at network level together with its Member States?

As of today, many nations already have a full strategic civil-military ATM dialogue, established and supported by civil-military steering bodies, which are mandated and represented at the national political level (Ministries), or the relevant management level. These nations offer an example that needs promoting. A key common aim could be the coordination and synchronisation of strategic civil-military decisions; this would enable nationally coordinated positions, and proposals for representation at both national and international levels (EU, SES, European Defence Agency (EDA), NATO, ICAO) as well as the harmonisation and synchronisation of the implementation of SES legislation. Clearly, we should continue to exploit the opportunities that lie in the common usage of infrastructure, procurement procedures and the cost reduction of resource pooling and sharing. This should be embraced by an optimisation of procedures and processes.

Flexible use of airspace (FUA), supported by an integrated Airspace Management Cell (AMC) jointly manned by civil and military planners should be the norm across all nations in Europe. An integrated AMC guarantees a balanced civil-military airspace management process that considers military effectiveness for the delivery of exercise and training missions, as well as expeditious civil air traffic flows.

In addition, I will attend future symposia, such as the NATO Air Chiefs Symposium, to enhance the civil-military network. I also intend to visit all EUROCONTROL Member States’ Air Chiefs, to introduce myself and learn where we can collaborate and improve our relationship.

What in your view is EUROCONTROL’s role concerning military and civil-military cooperation in the context of EU and NATO?

In simple military terms, EU and NATO are strategic-level organisations, whereas EUROCONTROL is one stage below at the operational and technical level, translating strategy into practical guidance for tactical execution. Only EUROCONTROL, with its unique civil-military nature, is practically capable to fulfil this function for aviation in Europe. A perfect practical example for the EU side is the NF-IR (strategic level) that is managed by EUROCONTROL as
Network Manager (NM) (operational level) including all of its civil-military cooperation needs and transposed via the NM cooperative decision-making process into real actions for airlines, air navigation service providers (ANSPs), airports and, where applicable, the military. Concerning NATO, in addition to the security cooperation through the NEASCOG1, EUROCONTROL is providing the operational civil-military coordination to enable the executions of NATO’s strategic aims. For example, as Network Manager, EUROCONTROL played a key role in NATO’s Rapid Air Mobility (RAM) process (most recently implemented during the COVID-19 outbreak) with prioritising flights carrying medical supplies, thus minimising the impact of COVID-19 on Europe’s citizens. As former Chief of Staff of NATO’s Headquarters Allied Air Command, I can assure you that the partnership between NATO and EUROCONTROL is vital for the delivery of real-time measures that allow operational delivery. It is not just operations that benefit from a close working relationship; EUROCONTROL has participated in several recent exercises, ensuring knowledge transfer and building a strong foundation for future partnerships.

The next generation of fighters introduce new concepts that require more airspace, add unmanned technologies and new operational networks. How will this impact civil-military airspace management and how will this be best coordinated between the civil and the military side?

Modern aircraft like 5th-generation fighters and unmanned aircraft systems (UAS) need to be integrated into existing airspace and ATM arrangements. This is not just for military purposes, but also for civil, commercial and leisure use, acknowledging the fact that legacy and modern aircraft have to co-exist in the future. Additionally, to face the growing challenges presented by the rising numbers of UAS, the development of the U-space system as a framework to track the development and deployment of a fully automated drone management system, and the integration of this system, is a major task for the near future.

Over time, FUA will be the most realistic solution for the increasing number of modern fighters to the challenge of identifying larger airspaces and cross-border operations.

What measures are the military taking to ensure airspace is released as early as possible for civil use and is the civil side taking full benefit of the airspace made available?

Besides the current ASM procedures in place that generally provide a stable picture of active and non-active ARES about three hours before the event, the military also tactically releases airspace as expeditiously as possible. Furthermore, ARES is becoming more and more modular in volume, only using the airspace that is needed for respective aerial training.

Since the implementation of FUA in the late 1990s, the military has invested efforts and resources to flexibly offer unused ARES to civil aviation; however, this additional airspace provided to civil aviation does not seem to be used to the best possible extent. Recent initial analysis indicates that even on weekends, when usually no military training activities take place, ARES is circumnavigated by civil aviation, adding to the shortest possible route and creating additional fuel burn. We need to understand the reasons behind this and develop corrective actions to ensure that civil aviation takes full advantage of the airspace opportunities.

Do you see options for better cooperation between the military and NM to further enhance FUA?

The future of airspace management is one that is full of opportunity; I envisage a future that has a fully automated FUA process. Particularly for large training areas that accommodate combined fighter training in areas where traffic and weather would make that suitable (e.g. southern Europe). Automation has never been more important, especially with the demands for more airspace that come hand-in-hand with the introduction of more 5th generation aircraft, and the inclusion of UAS into controlled airspace.

Generally, we need to implement a better awareness among military personnel of the Network Manager Operation Cell (NMOC) and its civil-military coordination options through the Military Liaison Officer (MILO) function. Currently, as far as I am aware, only a couple of military experts even know of its existence.

Last, but by no means least, I want to strengthen the relationship of EUROCONTROL with the military, and raise awareness by promoting participation in joint civil-military exercises. I know this has been done before, but the benefits are substantial, and I hope we can improve this further.

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1 NATO-EUROCONTROL ATM Security Coordinating Group
2 Airspace Reservation, usually for military purposes

“Flexible use of airspace should be the norm across all nations in Europe”
Sustainability is a major focus for aviation as a whole. What is being done on the military ATM side to address the sustainability of military aviation going forward?

From a purely military perspective there are three main dimensions that should be looked at.

The first dimension is about optimisation of fleet, trajectories and all actions that could be taken to reduce the dependence of the military on carbon energy. Many national militaries are already working in this field, with actions ranging from technical modifications to reduce fuel consumption, via increased use of biofuel to alternative energy supply on military installations.

The second dimension is more related to adaptation measures to mitigate the risks related to climate change on military infrastructure and operations. Military infrastructure and military operations will be impacted by climate change like any other operational infrastructure/stakeholder. Therefore it is essential to assess and identify the risks of climate change on their operations (for instance, the rise of sea-level could impact military airports close to the sea) and work on mitigating those risks.

The third dimension relates to the potential that resides in more effective ASM/FUA as military support for reducing fuel burned and CO2 produced by civil aviation, which could likely be the largest military contribution to CO2 overall reduction on the aviation side.

I understand that EUROCONTROL has recently published a report on climate change risks for European aviation that among other things has identified for Europe 26 military or public/military airports with a risk of flooding. I think that the findings of this study (Climate change adaptation – quantification of risks and mitigation) should be used as a starting point for developing further mitigation actions.

The US the Department of Defense, for example, has already started looking at this from a national security and infrastructure perspective, other states’ militaries may have done similar exercises. There has also been some academic work done on potential impacts on the military.

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“..."It is essential to assess and identify the risks of climate change on military operations and work on mitigating those risks"
NETWORK MANAGER DEVELOPS NEW CONCEPTS TO ACCOMMODATE NEXT GENERATION AIRSPACE USERS

Space rockets, drones, hypersonic airliners, airships, high altitude platforms, more exotic military aircraft and swarms – the airspace above Europe will be very different in 2035 than now. How will the Network Manager integrate all these airspace users? Steven Moore, Head of ATM Network Operations, Dragos Tonea, iNEO Manager and Paul O’Reilly, New Entrants Airspace Specialist report.
Europe’s rapidly growing space industry is pushing traditional airspace boundaries and challenging the current status quo. Approximately 17 sites are under development across Europe and North Africa to support commercial operations with Virgin Orbit planning its first departure from Spaceport Cornwall within 12 months, and predicting monthly departures within five years.

But space rockets are not the only new entrants needing to access Europe’s upper airspace. Stratospheric balloons up to 300 m in length and capable of staying aloft for months at a time provide connectivity and surveillance services; fixed-wing solar-powered craft offer high-quality telecommunications; hypersonic passenger transport and military craft add new operational concepts; while airships provide disaster relief, cargo and passenger services. Ensuring these new platforms can safely use the airspace alongside manned aviation is the focus of the Integration of New Entrants into European ATM Network Operations (iNEO) project within the EUROCONTROL Network Manager Operations Directorate.

Dragos Tonea, iNEO Manager, says iNEO provides a “one-stop-shop” to manage all aspects including new entrants’ operational needs as well as interfacing with external partners and research programmes. “Air Traffic Management (ATM) is being asked to play a role in a bigger global game when it comes to commercial space. This massive market is not linked to the traditional aviation market and has resources that dwarf the ATM sector.”

iNEO’s work extends to all future airspace users, including small Unmanned Aerial Systems (UAS) operating at very low altitudes, Remotely Piloted Aircraft Systems (RPAS) flying above commercial airspace, supersonic and hypersonic craft. “We need to make sure every new entrant in the future will be included in the European network plan, we need to bring them into the planning process,” adds Dragos Tonea.

Developing relevant infrastructure, involving industry, securing military cooperation and addressing contingency management are priority items for EUROCONTROL Head of ATM Network Operations, Steven Moore: “All of EUROCONTROL’s 41 member states plus associate members Israel and Morocco have to engage, to a greater or lesser extent, and give permission where relevant for these companies to operate in their airspace.” The work includes understanding how new entrants will operate and working out how to cooperate effectively with them. “Collaboration at planning stage is important to achieve as close to a synonymous approach for all as possible.”

EUROCONTROL and the European Space Agency (ESA) are part-way along this road under an existing Memorandum of Cooperation, an agreement that could be amplified to include communication protocols to support tactical exchange of data. As exchanges are also likely outside European borders – for example overseas commercial space operators launching in the Atlantic directly impact traffic flows in Europe – managing the quality, origin and convenience of any data is essential for its inclusion in decision-making.

A MODEL FOR HIGHER AIRSPACE

NM is also reviewing its strategic role. The NM Operations Centre (NMOC) balances capacity supply and demand for commercial aircraft up to Flight Level 600 (FL600), supporting the operations of 68 individual control centres. “One of our key objectives is to optimise the airspace organisation that will underpin future high altitude operations,” says Dragos Tonea. “We have a huge opportunity to learn from the lessons of the past. Putting a whole new class of users at the core of service provision and operating in a more unified manner to provide a continuum of upper airspace would send the message that Europe is open for business for new entrants.”

The concept of a European Upper Flight Information Region (EUIR) introduced in the Airspace Architecture Study published by Europe’s airspace modernisation research arm SESAR in the 2019 is a potential template for Higher Airspace Traffic Management (HATM).

SESAR is co-funding another project addressing new entrants, including High Altitude Platform Systems (HAPS), that will also feed into the development of an ICAO global framework for global harmonised higher airspace operations. Coordinated by EUROCONTROL, Europe’s Concept for Higher Airspace Operation (ECHO) project is due to release a concept of operations for safe, efficient and scalable higher airspace operations in 2022. The consortium includes key players from industry (Dassault Aviation, Airbus, ThalesAlenia Space), strategic partners (ENAC, DGAC/DSNA, ENAV) and leading

PROCEDURES AND PROTOCOLS

The aim is to design common procedures to provide new-to-market operators with a clear view of what they need to do to gain access. EUROCONTROL Network Director of Operations (NDOP) working group, the body that sits between the Air Navigation Service Providers (ANSPs) and member states, has started to review process changes needed in areas most affected by the growing commercial space sector with major actors such as Spain, Portugal, France and the UK already actively engaged.

The Network Manager (NM) is also examining performance and security requirements of its external interfaces. These need to support data exchange with national space agencies and commercial operators not tied to existing state-managed or military standards. EUROCONTROL New Entrants Airspace Specialist, Paul O’Reilly is engaging with these entities to define operating parameters and vehicle characteristics. “We are talking with the Portuguese, Norwegian, UK and Swedish space agencies and several operators including Virgin Orbital, Black Arrow, SaxaVord Spaceport in Scotland as well as airship operators including Obelisk in Germany.” With eight space sites in the UK, two in Germany and one in each of Sweden, Norway, Spain, Italy and the Azores, building good communications will be key to accommodating their navigational needs in commercial airspace.

A MODEL FOR HIGHER AIRSPACE
“ATM is being asked to play a role in a bigger global game when it comes to commercial space”

research organisations (DLR, ONERA, CIRA, ENAC). “Our role in the context of ECHO is to make sure there is an operational level playing field for new entrants, and we develop future-proof solutions for the benefit of the entire European network,” says the project’s operational lead Dragos Tonea. “We shouldn’t assume the classic way of managing traffic is the only solution that could be envisaged for higher airspace.”

In the meantime, NM handles new entrants on an ad hoc basis with existing procedures. Much like a military mission, NM creates the equivalent of a danger area or safety envelope around a new entrant for the duration of its flight in commercial airspace. As the number and type of vehicles continue to increase, this becomes increasingly complex with potential adverse economic impact on existing commercial traffic.

A further challenge is the increase in space debris, often with low windows of accuracy, re-entering the airspace. NM Crisis Coordination and Management unit works closely with the EU Space Surveillance and Tracking (EUSST) agency and follows readily available information from many sources as soon as it becomes available. “We would like to predict more accurately where the problem is going to be,” says Steven Moore, adding the amount of space debris re-entering is due to triple by 2026. “We are applying machine learning and artificial intelligence to better understand the change to the statistical risks associated with this.”

A more mature space market in the US has seen the Federal Aviation Administration (FAA) develop a Space Data Integrator (SDI) software tool that automates delivery of vehicle-related data to the FAA’s Air Traffic Control System Command Center in Virginia. First used in June 2021 for SpaceX Transponder’s launch, SDI helps the FAA to manage the airspace more dynamically and minimise the impact on other airspace users. The agency says it has reduced the length of airspace closures from an average of more than four hours per launch to just more than two hours. NM believes there is a strong case for a dedicated space desk in NM operations room modelled on the US solution.

NM is evaluating opportunities to develop a European solution – an initiative that stands to benefit from the existing Memorandum of Cooperation between EUROCONTROL and the FAA. The German research agency DLR has also begun exploratory research into the integration of space and air traffic data in Europe, supported by a separate MoC with the FAA signed in 2019 which aims “to advance commercial space transportation solutions”.

Dragos Tonea says: “The conversation is just starting at our end. We need to make sure the technical solution matches the environment. Some NMOC competencies are similar to the Command Centre but, given the specificities of the European ATM environment, plenty are firmly under responsibility of states and ANSPs including civil-military interfaces.” He says the Commission’s European Space Traffic Management (EUSTM) programme launched in February 2021 is just one crucial development relevant for this work. “Any solution has to operate as part of a wider ecosystem that incorporates aviation and space.”

Development of a space data tool falls within EUROCONTROL’s broader digital transformation programme and 10-year integrated NM (iNM) modernisation project launched in 2019. This aims to provide the foundational enterprise architecture and flexible interfaces needed for NM to evolve. Steven Moore explains: “NM is taking this step by step and involving the top experts in this discussion. You can’t quantify the value of sharing and understanding very complex operational and technical issues in monetary terms, but over the course of last 20-30 years this approach has been essential to building European ATM architecture.” He adds that ATM is being asked to play a role in a bigger global game when it comes to commercial space. “There is a massive market out there with tremendous resources behind it which is not linked to the traditional aviation market and the value of these resources is driving ATM development.”
Charlotte Neyret started work as the new Chief Executive Officer of European Satellite Service Provider (ESSP) in October 2021. She has been a passionate advocate of the aerospace industry for many years, starting as an engineer, then taking on responsibilities in Sales, Marketing and Business Development in the Space, ATM and telecoms domains before becoming Director of New Business Initiatives with Thales Alenia Space.

Her arrival in the Toulouse/Madrid-based company coincides with the beginning of a new period for ESSP, the company created by seven key European Air Navigation Services Providers (ANSPs) to deploy the EGNOS Service Provision contract (ESP). The EGNOS contract is funded by the European Commission and managed through the EUSPA (European Union Agency for the Space Program), formerly the European GNSS Agency (GSA), with a clear mandate to help foster the use of satellite navigation within European industry, particularly aviation, and among citizens.

“ESSP’s core activity is the delivery of the ESP (EGNOS Service Provision) contract with the EUSPA,” says Charlotte Neyret. EGNOS is a satellite-based navigation service that improves the accuracy and integrity of the GPS signal (as well as very soon the Galileo signal) over Europe, which makes it very suitable for safety applications such as flying aircraft and many other uses. EGNOS benefits include improving accessibility in airports — especially in bad weather conditions — more direct en-route flight paths, reducing and simplifying equipment on board aircraft. Best of all, the service is free to ANSPs. All that is needed is an on-board EGNOS certified receiver, plus an adapted approach procedure for the runway end.

How do you see the company changing in five years time?

The company is sustainable and solid. My main priority is first to maintain a good quality of service and the appropriate level of security, delivering high performance for aviation and other users. Secondly, it is to continue the development of the company and to ensure long term sustainable growth — the business is not transformational but evolutionary answering to market needs and being closer to its end-users.

It is important to take care to not destabilise services while proposing new ideas, while taking the benefits of my 24 years’ experience in the aerospace sector. A diversification of the company, so far fully dedicated to the provision of the EGNOS services, is on-going and I will pursue it.

The most important thing is team spirit, to give ambitious, credible objectives and a sense of what we are doing and where we are going. In five years’ time ESSP will be a multi-service company addressing new markets. The aerospace sector is moving fast and based on its assets, ESSP has a very promising future to support its stakeholders.

How will your activities contribute to the future development of satellite navigation based services?

EGNOS is a real asset in increasing the competitiveness of users, particularly for the aeronautical sector which has faced an unprecedented crisis. ESSP will contribute to deliver added-value multi-application services based on accurate navigation data, with integrity, gathered with environmental and observation data.

ESSP, as a certified operator with all the accreditations, should play a key role in all CNS satellite-based services for piloted and non-piloted aircraft and for the space traffic management, for civil and defence needs. ESSP will contribute to the development of the satellite-based navigation services in Europe and worldwide.

What are key projects is ESSP involved in?

Beyond its daily activities to operate the EGNOS system and to provide services, ESSP supports the development of EGNOS’s growing user-group by promoting new usages for all transport sectors. It is currently contributing to the development of new standards for maritime receivers, for example. ESSP is assisting industry in the development of the new EGNOS releases and in the definition of the next generation of the SBAS system to prepare the future of navigation. ESSP also eases international SBAS deployments with engineering and capacity-building contracts for Korean and ASECNA projects.

ESSP also contributes to the ESA Iris programme, aiming to become the provider of satellite-based, certified datalink services, critical to the digital transformation of Europe’s airspace.

“It is a great honour to be assuming this role at this time, and to have the opportunity to help ESSP keep playing an important role in helping this sector build back better from the global pandemic,” Mrs. Neyret said.
The launch in September 2021 of EUROCONTROL’s Innovation Hub in Brétigny – as a replacement for the former Experimental Centre – is far more than just a rebranding exercise. It describes a new way of working for the Agency, connecting more closely with end-users to develop a hub which focuses on agile, digital solutions and services that accelerate the uptake of Single European Sky ATM research (SESAR) solutions. Laurent Renou, Head of Air Transport Innovation at EUROCONTROL, describes what changes this will bring to innovative air traffic management in Europe.
How different will the EUROCONTROL Innovation Hub be from the Experimental Centre?

I think we’ll transition from academic research to innovation that delivers value to our stakeholders. With research you increase your knowledge; with innovation you use this knowledge and apply it to solutions that address the needs of the end users. With this transition we will work more closely with our operational end users: air navigation service providers (ANSPs), air traffic controllers, airport operators and airspace users – civil and military.

We are not a centre where we will do everything in-house. We’re a hub where we connect operational stakeholders with innovative initiatives. And this means more and more digital innovation, not necessarily specific to air traffic management (ATM). You can see increasing automation in the road transport sector and we should benefit from this knowledge and learn how to apply it to ATM. We are going to increase our scope by targeting airports and airspace users.

It is clear digitisation will lead to some fundamental technology and institutional challenges for ANSPs. Asking them to replace national ATM infrastructure with a system-wide digital service is a particular challenge. What will your role be in helping to ensure this new way of working will be safe and resilient?

One of the objectives of the SESAR programme is the evolution of ATM systems from nationally-based networks to, potentially, architectures that could be the same for more than one country, making ATM far more cost-effective.

That’s the goal of the Virtual Centre, where some key components could be horizontally delivered, rather than vertically. In this way, digitalisation can be introduced both nationally and transversally.

We could benefit from other industries’ experience in this area, because we are not the only ones doing it.

From the start, we have to define a digital system that is safe and secure by design. EUROCONTROL can help provide this at a national level but also – as the goal of EUROCONTROL is always to build a network capability – across several States so experiences from one country can be shared elsewhere.

We are in discussions with other industries on how this can be done. We will work with research centres in the automobile sector, for example, where autonomous car designs are being developed to be cyber-attack resilient.

In SESAR 2020 we are leading one of the projects working on developing virtualisation capabilities, a key enabler for ATM modernisation. We will finalise the industrial research and then help move it to deployment, as part of the SESAR 3 programme. We are also progressing on trajectory-based operations, which will increasingly rely on digital communication between aircraft and controller. Through all this data the use of artificial intelligence will be needed and will represent a real game changer.

Until now many aspects of automation have been developed through algorithms providing an essentially determinist approach. Now we are also looking at automation through the application of artificial intelligence – which will raise questions on how to certify an automated system that is not predictable.

Applying machine learning to ATM digitisation will be challenging but potentially rewarding. What will be the benefits in areas such as improved predictability?

I think for network predictability, the use of ADS-B data from the aircraft will be one key enabler to improvement. Another is 4D trajectory management, so data on an aircraft’s trajectory can be downlinked to the ground. These are two enablers we are working on right now.

Another important research area for us is to integrate all this information and improve data collection from the aircraft. Instead of trying to guess what the airlines are doing, or plan to do, ground systems can now use this data.

How successful have you been in talking to the airlines about accessing data which has historically been seen as commercially sensitive?

We cannot take confidence and trust for granted. We have to gain it. With distributed machine learning, which requires large amounts of data from all stakeholders to enable network analysis and prediction, you can interrogate data without inputting it into your system, so we hope that will allow us to use airline data which airlines can still keep private.

What performance improvements could this deliver?

As soon as you have better predictability, there will be fewer diversions from the optimum trajectory that will burn the least fuel. So if any tactical interventions are needed, it will be because an action has to be taken and not because there is a safety margin built in.

This means we can reduce tactical interventions, improve network predictability and increase aviation’s sustainability.

Do we know by how much? Have you got any target figures?

The recent impact assessment done by EUROCONTROL confirms that air traffic management impacts the optimum trajectory by 8-11%. Not all of this is linked to route predictability, but in terms of targets, horizontal inefficiency could be improved by around 3% to 4% and vertical inefficiency by around 2% to 3%.

If we look at the work done for the European Airspace Architecture Study – and especially the contributions from the
EUROCONTROL Network Manager – we now have a blueprint for a perfect airspace design linked via the SESAR programme to the new technology required to support this design.

So far, the focus has been on en-route airspace improvements through better predictability and trajectory-based operations but we are also now working on this in the terminal manoeuvring area (TMA) environment, looking at approach/TMA operations optimisation, potentially moving towards a dynamic TMA based on traffic flow.

If you have a static TMA design by default, and you have to comply with it, it’s less efficient. But if you can adapt the TMA design to the traffic flow, you can allow the aircraft to fly as close as possible to its optimum trajectory.

How important is EUROCONTROL Brétigny in terms of moving this technology forward?

EUROCONTROL Brétigny is unique in that we can provide all the simulation facilities needed at the European level. We can simulate any airspace in Europe, from current versions to future SESAR concepts. We can simulate a new concept, assess its impact, acceptability, performance impact and so on – not merely in generic terms but how it would relate to the airspace in France, Turkey or Germany, or the interface between two States.

Either through fast-time or real-time simulations, we are also developing a unique set of tools to provide an impact assessment in terms of noise and emissions.

EUROCONTROL is also leading the European Concept for Higher Airspace Operation (the ECHO project), defining the concept. Once that has been done we will need to assess it, and this can be carried out in our real-time simulation facilities, to make sure that this can be safely integrated into ATM operations.

We want to develop all these innovation initiatives to bring agility into the SESAR programme – and beyond, into the world of drones and other new airspace users. We foresee a future of working with many different stakeholders. EUROCONTROL Brétigny has the capability to make the bridge between research and operations.

How will you work with other European aerospace research centres?

We do not want to compete but to cooperate with them. We will use the results of their research, apply them to address operational stakeholders’ needs and accelerate the deployment.

It can be difficult to change the mindset from researching a solution to addressing the real needs of stakeholders. We want other centres to see us a hub, the driver for implementing their research. We are not industry and we are not going to sell a product – our solutions are in the public domain and our goal is to hand them over to industry and support as much as we can in order to deploy them as quickly as possible.

How much of your work is focused on SESAR research?

The benefit of SESAR programme is that it brings all stakeholders working together on a common plan, and this is absolutely needed because Europe is fragmented, unlike the USA.

But the other side of the coin is that it really lacks agility – you have only two years of actual work out of a four-year cycle (wave) due to the time needed to prepare the call for projects, answer and have the grant agreement. In the world of innovation you have new ideas on almost a monthly basis. So if you have a new idea for an innovative line of research six months after the publication of the SESAR call, it’s too late. You will have to wait three years before you can work on it.

What we will provide now in our Innovation Hub at Brétigny is the opportunity to bring agility into the SESAR programme, to complement it by asking operational stakeholders for their requirements on a six-monthly basis. We will ask them to choose the technology challenge they would like us to focus on.

In this way we can develop a network of operators – airports, airspace users, air navigation service providers – who together will define the operational needs that they want EUROCONTROL to address.

We expect that 100% of our innovation activities will support European aviation modernisation and make SESAR 3 a success.
Peter Green, Head of Standardisation at EUROCONTROL, highlights the ways standardisation of SWIM services can support the development of the future ecosystem to accommodate emerging airspace users such as High-Altitude Platform Systems (HAPS), Urban Air Mobility (UAM), commercial space vehicles, supersonic airliners and drones.
When we talk about enabling the full range of new entrants, we need to consider the specificity of their operations and the data services required by these and existing users. Standardisation can help accelerate the deployment of data services by ensuring that new System Wide Information Management (SWIM) services can be deployed as new concepts emerge.

SWIM is the platform for quickly enabling new services based on agreed standards and best practices in information technology including a Service Oriented Approach (SOA). With SWIM, business services interoperability is enabled, focusing on all aspects related to harmonised exchange of information, from data exchange formats and protocols (syntactic interoperability), to information semantics, reducing deployment costs and time.

SWIM IS HERE NOW

SWIM is already in operation with initial use mandated through the European Commission’s Pilot Common Project. The Network Manager (NM) has been a pioneer of SWIM deployment with the Business-to-Business (NM B2B) web services covering flight services (flight preparation, flight plan filing and management), airspace services (management and publication of airspace information), general information services and flow services (flow & capacity management).

In addition, air navigation service providers (ANSPs) and airports are also deploying SWIM services in various information domains:

- **Aeronautical Information Management** services like Map Information, Aeronautical Information Feature and Aeronautical Information Map are focused on the exchange of aeronautical information and the provision of digital maps to increase cooperation and functionality.

- **MET Hazard Service** is focused on a harmonised, pan-European framework for weather information availability to all users that defines the services of exchanging weather phenomena data. Using the new access points, the MET data can be made available, improving planning, optimising flight paths and reducing delays. Its related services (en-route forecast, METAR, MET Report and terminal aerodrome forecasting (TAF)) aim for an increased interoperability via SWIM, and therefore they are proposed for standardisation.

- **A-CDM (Airport Collaborative Decision-Making) service** provides situational awareness at airports on flights and times. With the help of SWIM, these will be enhanced, providing more accurate and real-time planning operations.

- **AMAN (Arrival Manager)**, a project deployed in many countries to support air traffic controllers by an automated sequencing, will be improved with SWIM service between the entities to ensure a proper coordination between the existing AMAN systems and the air traffic service units (ATSUs). In the context of extended AMAN concept horizon, services consuming arrival information such as the Arrival Planning and the arrival management input services are proposed for standardisation. Their focus is on AMAN information provided to the ATSUs, arrival sequence calculation and traffic sequencing improvements.

- **Virtual Centre services** enable decoupling controller human-machine interfaces (HMIs) and flight data processing (FDP) systems to allow for the use of FDP services across several ANSPs without the need to develop a physical system. This relates to several services such as airspace status distribution, correlation distribution, coordination and transfer management, datalink management, flight data management, flight data distribution and operational configuration distribution.

As industry further adopts SWIM for these and other services, critical mass can be achieved and speed of deployment increases. This emphasises how targeted standardisation activities with all civil and military stakeholders in support of deployment, contributes to better infrastructure, services and business efficiency.

THE FUTURE OF INFRASTRUCTURE IS YELLOW

The Technical Infrastructure (TI) layer in SWIM addresses the protocols (standardised technical interfaces) and configurations needed for the exchange of information between systems including security requirements. The TI requirements for different types of service are described in profiles – each with its own colour.

The Yellow Profile is currently the only TI profile that is standardised and required by regulation, being deployed widely in support of many heterogeneous services. It provides a common infrastructure baseline that fulfils or can be extended to fulfil most of the services required by current and future users. It is described in all necessary detail in the EUROCONTROL Specification for SWIM Technical Infrastructure (TI) Yellow Profile, which is freely available on the EUROCONTROL website. The use cases of the Yellow
Profile or others will expand to other areas of air traffic management (ATM).

COMPLIANT SERVICES BENEFIT US ALL

To deploy a new business service requires a SWIM service to be developed and placed in the SWIM registry. Service providers identify services and advertise them in the registry. It is like the internet but a managed and regulated internet with authorised users, validated services and proper security. An internet suitable for aviation.

That does of course mean that getting your service into the SWIM registry comes with suitable hurdles to protect the overall stability and security of the system. Clearing those hurdles means adhering to the underpinning standards for describing SWIM services:

- **EUROCONTROL Specification for SWIM Service Description**: These are the requirements for describing information services. They cover service consumers’ needs and consider services from a business, operational and technical point of view. The details of a deployed service such as behaviours, information provided, legal and security constraints are included and made available to consumers for a better understanding of what the service does and how it works. This helps users to assess the operational and technical data in terms of usage and quality. In support of business decision-making, the standard provides a list of general requirements and service interface requirements.

- **EUROCONTROL Specification for SWIM Information Definition**: The Information Definition standard on the other hand presents information definitions specifications, known as formal descriptions of the exchanged information that ensures a cleared and harmonised shared information. It aims at information to be clearly defined, understood and harmonised between stakeholders contributing to semantic interoperability. The specification enables the use of common data definitions as described in the ATM Information Reference Model (AIRM).

Where a SWIM service has a wide role requiring use by many users, it may help for the Service Description to be standardised (for example EUROCAE specification for the Extended AMAN Service), but well-formed service descriptions can be approved for use (and operationally validated in multiple environments) without this step. This may well be crucial for helping new entrants access the aviation and ATM data that best suits them – weather information at different altitudes, current usage of very low-level airspace or declaration of emergencies requiring short notice cancellation of planned missions. SWIM is not just about service providers defining the services, but also about the users helping to refine those services in line with their business needs. This is genuine interoperability, not harmonisation. Subtle flavours of the same basic service can exist to support specific requirements and it is this flexibility that will really help UAM and Space Tour operators access the data they need.

SWIM IS THE UNIVERSAL ENABLER

Over the recent years, the ATM industry has successfully implemented several projects based on SWIM. The benefits, in terms of systems connectivity and flexibility of service design, are increasing confidence that a smooth transition to the future system is within reach for all aviation stakeholders.

As we move forward to the Digital European Sky, future concept developers can rely on SWIM as a universal enabler for the safe and secure exchange of data of all users of the airspace existing or emerging.

References

“As we move forward to the Digital European Sky, future concept developers can rely on SWIM as a universal enabler for the safe and secure exchange of data of all users of the airspace existing or emerging”
ECHO IS MAKING SPACE FOR NEW HIGH-ALTITUDE ENTRANTS

Henk Hof, ECHO Project Leader at EUROCONTROL explains how EUROCONTROL and partners are developing a concept of operations for the higher airspace.

The higher airspace (airspace approximately 60,000 ft) is no longer exclusive to space rockets and military spy planes, but hosts an expanding range of long-endurance balloons, High Altitude Platform Stations (HAPS), supersonic and hypersonic aircraft. With missions varying from connectivity and surveillance to passenger transport and satellite services, these vehicles with vastly different operating characteristics present a new airspace management challenge.

European safety agencies are responding in partnership with industry to define the principles and operational assumptions that will enable development of a Concept of Operations (ConOps) for higher airspace. The European Commission tasked the European Union Aviation Safety Agency (EASA) with preparing a regulatory framework and the EUROCONTROL Higher Airspace Operations Symposium in April 2019 set out some high-level principles. The initiative gained further momentum in November 2020 when the SESAR Joint Undertaking (SJU) secured Horizon 2020 funding for the two-year ECHO project to develop higher airspace ConOps. ECHO is supported by an advisory group including EASA, the European Space Agency (ESA) and the European Defence Agency (EDA) that facilitates consistency between the regulatory framework and ConOps development.

ECHO is on track to deliver a comprehensive demand analysis and ConOps to allow safe, efficient and scalable operations. A key objective is to address operations of vehicles today as well as of vehicles and activities still to be developed, hence the project identifies short-, medium- and long-term timeframes and is expected to feed into ICAO efforts to develop global guidance material.

ECHO Project Leader Henk Hof says the higher airspace provides an enormous opportunity for the airspace management industry generally. “We have a chance from the start to take a pan-European approach rather than a state or national perspective. Additionally, the absence of legacy technology presents a unique proving ground for innovation. It allows information sharing, collaborative processes, System Wide Information Management (SWIM), trajectory-based operations and other ICAO concepts to take a giant step forward.” Once they have been shown to work, these new concepts can then be made available for use in the airspace below.

Among ECHO’s first actions, the project released a series of principles and assumptions regarding higher airspace in early 2021. This sets out the safety objectives, airspace access, security and defence, civil-military coordination and interfaces with other airspace and air traffic management. This was discussed at the first of three workshops involving the whole stakeholder community in mid-2021 to find out more about user requirements and obtain feedback. A second workshop in January 2022 will review the first ConOps document, followed by a third in July 2022 to provide final input.

“We need to get a picture of the demand,” explains Henk Hof. “There are clear developments in the commercial space category – for example states building spaceports and planning launches such as the UK, Italy and Sweden. It is also
possible to estimate super and hypersonic user requirements based on US developments like Boom Supersonic. The category where there is most uncertainty is high altitude platform systems (HAPS) which features all kinds of platforms with the ability to stay aloft for weeks or even months at a time.” ECHO has embarked on a series of interviews targeting specific companies to find out more about the performance characteristics of these airspace users.

The airspace boundary is another area of discussion, with some industry observers calling for an upper boundary as high as the Kármán line used to delineate the edge of space 100 km above the ground. As passenger-carrying hypersonic aircraft are planned to operate in sub-orbital airspace, it is important they are included within the scope of higher airspace ConOps. The lower boundary meanwhile is part of a wider debate about the role of the EUROCONTROL Network Manager (NM) – currently responsible for traffic flow management below FL600 – and higher airspace management services. For example, NM manages the allocation of transponder codes and radio frequencies on behalf of all airspace users and collaborates with military interests to support flexible use of airspace. ECHO Project Leader Henk Hof says adopting a pan-European approach to higher airspace traffic management is central to Europe’s ATM architecture and will allow people to gravitate towards the kind of structure that has made NM a success story.

Both NATO and EDA provide regular input into ECHO as part of efforts to define military requirements. Civil-military collaboration is a precondition for safe and efficient flight operations and this is likely to be supported by information sharing and collaborative decision-making processes. New entrants such as high-altitude platforms add to this complexity by performing both civil and military missions, while experience gained during the Google Loon trials shows these slow-moving craft can operate as low as FL550 depending on meteorological conditions. While still higher than most commercial traffic, this overlaps with some business jets and military craft. “We want to see the airspace as a continuum, unsegregated vertically as well as horizontally, with equal access for all users,” says Henk Hof.
Involving the HAPS community is central to the process of defining airspace requirements and HAPS developers Airbus and Thales Alenia Space are among ECHO industry partners providing input to the project. Under current procedures, airspace is reserved on a temporary basis to enable new operators to access controlled airspace while safeguarding existing users. “For the short term, we see no big changes,” says Hof. “Some new entrants can collaborate together in reserved airspace, for example taking advantage of Unmanned Traffic Management (UTM) technology and working together to avoid collisions. The reserved airspace can also move according to demand.” Other ECHO consortium partners include air navigation service providers (ANSPs), regulators and research agencies.

In the medium- and long-term, large-scale automation of the exchange of data between all actors is necessary to reach the integration phase of higher airspace operations. This anticipates the embedded use of Artificial Intelligence (AI) within a data-rich and cyber-secure connected ecosystem. Establishing an initial ConOps will encourage future airspace users to begin testing some of these systems and start defining the technologies they can deploy on their platforms.

“We can see higher airspace acting as an incubator for early implementation of concepts still under development. There are ideas we are working on in ICAO that are hard to introduce with older generation aircraft,” says Henk Hof. “We first need to establish a European view on how we want to organise high airspace, documented by ECHO. This time next year we will be much more informed, and we can take this to ICAO and use it to help define what is needed from ICAO.” With the current procedures likely to remain in place for at least the next five years, the industry has some time to adapt and develop the solutions necessary for future growth.
NEW INTEGRATED ATM/U-SPACE SERVICES AND CAPABILITIES WILL MEET THE AIRSPACE INTEGRATION CHALLENGES OF URBAN AIR MOBILITY

Over the last century, the development of the aviation industry has fundamentally changed the way we live, work and travel. During this time, aviation has never ceased to innovate and in the last few years, new types of aircraft have emerged, including Unmanned Aircraft Systems (UAS or drones) and Urban Air Mobility (UAM) aircraft. The latter might be electric Vertical Take-off and Landing (eVTOL), electric Conventional Take-off and Landing (eCTOL), and some are Personal Air Vehicles (PAV). With the development of these new aircraft types, aviation is once again taking a significant step forward.

People have always dreamed of using air travel to improve transport in and around cities. UAM is the realisation of that dream, enabled by advances in technology that among other things reduce the noise and size of aircraft. UAM has the potential to revolutionise the way people and goods move in and around cities by enabling point-to-point flights, bypassing ground congestion and shortening journey times.

The term “UAM” refers to on-demand, highly automated passenger or cargo-carrying air transport services in urban and suburban environments where aviation is highly regulated today. The UAM industry vision involves an ecosystem of new vehicle designs, system technologies, airspace management constructs, operational procedures and shared services that together enable an innovative and more integrated transport network as safe as that of today.

There is a solid business case for improved commute times and accelerated transport of goods across cities. The challenge
is to offer these in a sustainable way and electric air vehicles (eVTOLs, eCTOLs) and new types of operations can meet this need. Growth of UAS operations and the development of eVTOLs are bringing new applications, new business models and new concepts and operations that will cross all airspaces, and that the aviation community will have to integrate with current operations.

A large number of players, led by aerospace, automotive and technology companies are already investing billions of dollars working on UAM solutions and eVTOL technologies to enable runway-independent operations, with very high degrees of automation, up to and including fully autonomous aircraft. In this context, various studies and most operators envisage that in a few years, there will be a significant number of simultaneous operations around metropolitan areas and airports at altitudes up to 5,000 feet and speeds of up to 150 knots. Outwardly similar to a helicopter, eVTOL aircraft are somewhere between commercial aeroplanes and remotely controlled UAS, configured to typically carry cargo or 1-4 passengers on short trips (e.g. less than 100 km) into and out of urban areas.

The safe integration of these aircraft and operations into the airspace creates a challenge in terms of complexity and capacity limitations. There are an increasing number of research and development (R&D) projects and programmes around the world working towards addressing different aspects of this challenge, some of which are already flying aerial prototypes or full-scale eVTOL demonstrators looking at having initial UAM commercial services deployed in the next 3-5 years. At same time private and public firms, companies and government agencies are pouring billions of dollars of investments into eVTOL and broader UAM.

In the short-to-medium term, UAS/eVTOL aircraft will share the airspace with manned aircraft, relying more on datalink than voice communications as eVTOLs transition to autonomous operations. They will operate in airspace adjacent to commercial manned aviation (e.g. airports), and in airspace where several classes of users – military, police and emergency helicopters, UAS and general aviation (GA) – already operate. A safe and equitable integration of current and future operations is essential in these airspaces where traffic density and ground risks are high.

These airspaces will be managed by Unmanned Traffic Management, known as U-space in the European Union (EU), and by traditional Air Traffic Management (ATM) where safety requires it. Innovative ATM/U-space services and the development of smart, automated, interoperable and sustainable airspace and traffic management solutions will be key enablers for achieving the high level of airspace integration required while meeting the requirements of priority aviation such as manned security or emergency services. It follows, therefore, that the most critical success factor for UAM operations will be the ability to identify solutions that allow UAS, UAM/eVTOL and all the other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by ATM.

As this important and growing domain evolves, a new operational concept, regulations and standards will be necessary to incorporate the needs of existing and emerging airspace users and these will require being underpinned by existing and new technologies. The whole environment will also need to be interoperable and safely integrate with manned aviation and ATM.

In this framework, U-space has become a priority for the aviation industry as a whole, not only because integrating smaller drones and larger UAM operations into the current surveillance systems has become a challenge from a safety perspective.
The core of the CORUS-XUAM project will be the execution in 2022 of the six challenging demonstration campaigns in Belgium, France, Germany and the UK, Italy, Spain and Sweden that will:

- focus on different types of mission such as passenger transport, delivery, emergency response and surveillance;
- demonstrate integrated operations of both unmanned and manned aircraft;
- consider the required level of coordination between ATC and U-space including interaction with air traffic controllers and pilots;
- combine flights by eVTOLs with other traffic and operations in the CTRs of some major airports managed by ATM;
- demonstrate vertiport procedures, separation and required data services.

Stakeholder outreach is an important aspect of CORUS-XUAM, and it is essential that the outcomes of the project be as widely known as possible. Several major workshops and communication/dissemination activities have been programmed for during the life of the CORUS-XUAM project. The consortium held its first large workshop on U-space/UAM operational requirements at the end of September 2021, and a second workshop will be organised in February 2022 with the focus on the consolidated U-space Concept of Operations. A final dissemination event will take place in December 2022.

In addition to these demonstration activities, EUROCONTROL, through its management of CORUS-XUAM, is leading the transversal coordination of 17 SESAR projects related to U-space/UAM. The aim is to deliver valuable insights that will enable the European Commission, the EU Aviation Safety Agency (EASA), SJU and EUROCONTROL to develop and maintain the U-space research baseline (ConOps, requirements, link to the Master Plan) to accelerate a consistent deployment of U-space/UAM services at a European level.

EUROCONTROL’s management of CORUS-XUAM is part of the portfolio of activities performed by the Agency’s Drone Unit which, in collaboration with its institutional and industrial stakeholders, provides technical advice on U-space matters and promotes the harmonisation of U-space in Europe. In partnership with the European Commission, DG-Move, EASA and the SJU, the Drone Unit facilitates the sharing of lessons learned through the European Network of U-space Demonstrators that supports European businesses in transitioning from U-space demonstrations to implementations. EUROCONTROL monitors and reports the status of U-space demonstration projects and the implementation status of U-space services on annual basis in the context of this network.

For more information, please refer to: https://corus-xuam.eu

Opening the sky to these new classes of airspace users is also a political and economic imperative. With the adoption of the EU U-space regulatory package in April 2021, Europe is now on a fast track to implementing drone ecosystems throughout the continent. These regulations are an important step towards creating the well-functioning, trusted and safe enabling environment that we need to develop a competitive EU drone services market. The European UAM market is projected to be the fastest growing one in the period 2023-2030 and several EU countries such as Germany, Italy, Spain, France, Sweden, Belgium, as well as the UK are investing heavily in the development and procurement of U-space services and advanced eVTOL systems for commercial operations. It is hoped to start the deployment of some early UAM services around 2023-2025, enabling smarter, more efficient, and sustainable mobility, with clear added value for achieving Europe’s decarbonisation, digitalisation and resilience ambitions.

This challenge can only be achieved through an evolutionary development process ensuring parallel definition and deployment of appropriate advanced and interoperable U-space infrastructure, technologies and services that fit with expected types of operations and levels of demand. To support this, a balanced consortium of the most innovative research arms of the ATM, UAS and UAM industries, led by the EUROCONTROL Innovation Hub, launched CORUS-XUAM (Concept of Operations for euRopean U-space Services – eXtension for Urban Air Mobility) at the end of 2020. CORUS-XUAM is a demonstration project undertaken within the framework of the EU/SJU Horizon 2020 programme, and will further extend the SESAR U-space ConOps defined by the previous CORUS project to enable the safe and efficient integration of UAM operations. It addresses several validation objectives:

- that the CORUS-XUAM ConOps and its associated advanced U-space services be a sufficient basis for the development of smart, automated, interoperable and sustainable traffic management solutions that allow UAS, UAM/eVTOL and all other airspace users (manned and unmanned) to safely, securely, sustainably and efficiently operate in a controlled and fully integrated airspace while ensuring an effective interface with ATC;

- that the operational scenarios currently considered challenging will be possible (safely and sustainably) thanks to the advanced CORUS-XUAM U-space services in combination with advanced UAS/UAM technologies;

- that there will be no issues blocking the development and definition of an adequate legal and regulatory framework to support the safe integration of UAS/UAM operations with manned aviation.
Traffic Evolution
between worldwide regions (number of flights)
Jun-Sep 2021 vs Jun-Sep 2019

<table>
<thead>
<tr>
<th>REGION</th>
<th>JUN-SEP 2021</th>
<th>JUN-SEP 2019</th>
<th>CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-Europe*</td>
<td>2,195,634</td>
<td>3,294,612</td>
<td>-33%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; Asia/Pacific</td>
<td>54,157</td>
<td>100,432</td>
<td>-46%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; Mid-Atlantic</td>
<td>14,337</td>
<td>20,269</td>
<td>-29%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; Middle-East</td>
<td>109,341</td>
<td>199,053</td>
<td>-45%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; North Atlantic</td>
<td>81,120</td>
<td>175,757</td>
<td>-54%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; North-Africa</td>
<td>82,301</td>
<td>141,588</td>
<td>-42%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; Other Europe</td>
<td>75,053</td>
<td>160,884</td>
<td>-53%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; South-Atlantic</td>
<td>10,641</td>
<td>23,708</td>
<td>-55%</td>
</tr>
<tr>
<td>Europe &lt;-&gt; Southern Africa</td>
<td>26,457</td>
<td>37,415</td>
<td>-29%</td>
</tr>
<tr>
<td>Non Intra-Europe</td>
<td>453,407</td>
<td>859,106</td>
<td>-47%</td>
</tr>
</tbody>
</table>

* Europe = ECAC 44 Member States

Top 20 Traffic Flows

<table>
<thead>
<tr>
<th>RANK</th>
<th>COUNTRY PAIRS</th>
<th>AVERAGE DAILY FLIGHTS (JUN-SEP 2021)</th>
<th>CHANGE VS. 2019 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spain</td>
<td>Spain</td>
<td>1,139</td>
</tr>
<tr>
<td>2</td>
<td>France</td>
<td>France</td>
<td>994</td>
</tr>
<tr>
<td>3</td>
<td>Turkey</td>
<td>Turkey</td>
<td>927</td>
</tr>
<tr>
<td>4</td>
<td>Italy</td>
<td>Italy</td>
<td>874</td>
</tr>
<tr>
<td>5</td>
<td>Norway</td>
<td>Norway</td>
<td>700</td>
</tr>
<tr>
<td>6</td>
<td>United Kingdom</td>
<td>United Kingdom</td>
<td>677</td>
</tr>
<tr>
<td>7</td>
<td>Germany</td>
<td>Germany</td>
<td>501</td>
</tr>
<tr>
<td>8</td>
<td>Spain</td>
<td>United Kingdom</td>
<td>443</td>
</tr>
<tr>
<td>9</td>
<td>Germany</td>
<td>Spain</td>
<td>424</td>
</tr>
<tr>
<td>10</td>
<td>Greece</td>
<td>Greece</td>
<td>392</td>
</tr>
<tr>
<td>11</td>
<td>Germany</td>
<td>Turkey</td>
<td>321</td>
</tr>
<tr>
<td>12</td>
<td>France</td>
<td>Spain</td>
<td>291</td>
</tr>
<tr>
<td>13</td>
<td>Germany</td>
<td>Italy</td>
<td>261</td>
</tr>
<tr>
<td>14</td>
<td>France</td>
<td>Italy</td>
<td>246</td>
</tr>
<tr>
<td>15</td>
<td>Germany</td>
<td>Greece</td>
<td>244</td>
</tr>
<tr>
<td>16</td>
<td>Italy</td>
<td>Spain</td>
<td>242</td>
</tr>
<tr>
<td>17</td>
<td>Russian Federation</td>
<td>Turkey</td>
<td>210</td>
</tr>
<tr>
<td>18</td>
<td>Sweden</td>
<td>Sweden</td>
<td>200</td>
</tr>
<tr>
<td>19</td>
<td>France</td>
<td>Germany</td>
<td>197</td>
</tr>
<tr>
<td>20</td>
<td>Portugal</td>
<td>Portugal</td>
<td>165</td>
</tr>
</tbody>
</table>
Market Segments
Jun-Sep 2021 vs. Jun-Sep 2019

**TOTAL FLIGHTS**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>-36.1%</strong></td>
<td>2,724,330</td>
<td>4,263,785</td>
</tr>
</tbody>
</table>

**Traditional scheduled**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>-46.3%</strong></td>
<td>1,174,468</td>
<td>2,188,257</td>
</tr>
</tbody>
</table>

**Low-cost***

<table>
<thead>
<tr>
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<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>-41.4%</strong></td>
<td>772,722</td>
<td>1,319,734</td>
</tr>
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</table>

**Business aviation**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>+14.9%</strong></td>
<td>324,864</td>
<td>282,752</td>
</tr>
</tbody>
</table>

**All-cargo***

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>+8.3%</strong></td>
<td>119,836</td>
<td>110,681</td>
</tr>
</tbody>
</table>

**Other types**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>+16.3%</strong></td>
<td>110,622</td>
<td>95,093</td>
</tr>
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</table>

**Charter**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>-15.1%</strong></td>
<td>183,323</td>
<td>215,996</td>
</tr>
</tbody>
</table>

**Military**

<table>
<thead>
<tr>
<th></th>
<th>Jun-Sep 2021</th>
<th>Jun-Sep 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>-2.3%</strong></td>
<td>38,495</td>
<td>39,400</td>
</tr>
</tbody>
</table>

**Share of Total Flights**
for the period Jun-Sep

*All-cargo and Business Aviation* were the only segments to record growth in Europe.

*Traditional Scheduled and Low-Cost* are slowly recovering and were above 50% of 2019 levels during the summer month.
Daily Departures at Top Airports

Jun-Sep 2019 vs. Jun-Sep 2021

© EUROCONTROL-Aviation Intelligence Unit
### Top 20 Aircraft Operators

**Average daily flights**

*Jun-Sep 2021 vs Jun-Sep 2019*

<table>
<thead>
<tr>
<th></th>
<th>Operator</th>
<th>Flights</th>
<th>Change vs 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ryanair*</td>
<td>1992</td>
<td>-24%</td>
</tr>
<tr>
<td>2</td>
<td>Turkish Airlines</td>
<td>1196</td>
<td>-18%</td>
</tr>
<tr>
<td>3</td>
<td>easyJet*</td>
<td>894</td>
<td>-53%</td>
</tr>
<tr>
<td>4</td>
<td>Air France*</td>
<td>800</td>
<td>-37%</td>
</tr>
<tr>
<td>5</td>
<td>Lufthansa*</td>
<td>760</td>
<td>-52%</td>
</tr>
<tr>
<td>6</td>
<td>KLM*</td>
<td>649</td>
<td>-31%</td>
</tr>
<tr>
<td>7</td>
<td>Wizz Air*</td>
<td>576</td>
<td>-14%</td>
</tr>
<tr>
<td>8</td>
<td>Vueling</td>
<td>489</td>
<td>-33%</td>
</tr>
<tr>
<td>9</td>
<td>Pegasus</td>
<td>480</td>
<td>-7%</td>
</tr>
<tr>
<td>10</td>
<td>SAS*</td>
<td>375</td>
<td>-56%</td>
</tr>
<tr>
<td>11</td>
<td>British Airways*</td>
<td>319</td>
<td>-67%</td>
</tr>
<tr>
<td>12</td>
<td>Aegean*</td>
<td>315</td>
<td>-26%</td>
</tr>
<tr>
<td>13</td>
<td>Widerøe</td>
<td>309</td>
<td>-5%</td>
</tr>
<tr>
<td>14</td>
<td>Eurowings</td>
<td>295</td>
<td>-61%</td>
</tr>
<tr>
<td>15</td>
<td>TUI Group</td>
<td>272</td>
<td>-56%</td>
</tr>
<tr>
<td>16</td>
<td>Iberia*</td>
<td>263</td>
<td>-33%</td>
</tr>
<tr>
<td>17</td>
<td>SWISS</td>
<td>256</td>
<td>-50%</td>
</tr>
<tr>
<td>18</td>
<td>Alitalia*</td>
<td>254</td>
<td>-56%</td>
</tr>
<tr>
<td>19</td>
<td>Volotea</td>
<td>220</td>
<td>-13%</td>
</tr>
<tr>
<td>20</td>
<td>DHL*</td>
<td>220</td>
<td>+18%</td>
</tr>
</tbody>
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* Reference is made to the airline’s group
Organised by the EU Agency for the Space Programme (EUSPA) and the EGNOS Service Provider (ESSP), this year, the EGNOS Workshop will be an online event, live-streamed from 09:30 to 17:00 CET.

The workshop is the opportunity to learn more about the evolution of the EGNOS Safety of Life service and its growth in aviation ten years after it entered into force. Do not miss it!

You will also get first-hand information on the status and roadmap of EGNOS, its development and its implementation in other fields such as Maritime, Rail and Agriculture.

You will see notable user’s success stories and join us in commemorating the 10th Anniversary of the declaration of the EGNOS Safety of Life Service (SoL) for aviation in 2011!

Follow the link below to see the agenda and register!

Registration is open!

Thursday December, 2nd  09:30 - 17:00 CET
ONLINE

If you have any question, please write an email to egnos-workshop@essp-sas.eu
VCS3020X – true IT in ATM

Communication continues to be critical for airspace safety. Networks and communication technologies are now moving from legacy to digital means; radios will no longer be connected point-to-point but will be seen as a communication service in an IT-based environment. The IT revolution in ATM has just started. At Frequentis we master this paradigm shift by providing safe and secure communication solutions, taking advantage of modern IT concepts. Virtualisation, cloud-based systems and intelligent networks are the foundation of modern IT-based ATM technologies.

OUR SOLUTIONS: VCS3020X IT VCS | vitalsphere network performance | Advanced network monitoring