EASA
European Union Aviation Safety Agency

Proposal for a Roadmap on **Higher Airspace Operations**

Executive Summary

Following a mandate by the European Commission, and with the support of a Task Force of Member States, EASA explored the preparatory actions required for a future regulatory framework on higher airspace operations (HAO) above FL 550.

These operations which do not yet exist on a large scale in Europe can initially be defined as 'air transport operations carried out by various types of aircraft or vehicle systems in the volume of airspace above altitudes where the majority of air services are provided today (i.e. above FL 550)'.

The future development of these operations in a quasi-virgin environment offers a rare opportunity to test new concepts and approaches, for instance in air traffic management or with regard to the regulatory methodology. These operations may pose safety, security and environmental risks that will need to be addressed, to ensure a uniform approach to safety, security and sustainability of air transport in the EU.

However, various challenges affect the future definition of the regulatory framework: the exact timeline for the introduction of commercial operations remains uncertain, the vehicles and their operations are extremely diverse and sometimes qualify as aviation operations and sometimes as space operations, which has an impact in terms of regulatory competences.

Building on the work done in parallel by the ECHO project (SESAR JU/Eurocontrol), the Task Force identified 27 categories of future HAO vehicles and operations, some of which fall under the applicability of the Chicago Convention and of the EU Regulations on civil aviation. This is the case for instance of HAPS, supersonic and hypersonic aircraft operations. Other vehicles and operations qualify as space operations and remain under the competence of Member States, while others present hybrid characteristics that will deserve further assessment.
Following an initial analysis of the impact of future HAO on the existing EU regulatory framework from a total system perspective, it can be concluded that while the EU Treaties and Basic acts allow for some of these operations and give a shared competence to the EU to regulate some of them, notably those qualifying as civil aviation operations performed by aircraft under the scope of the EU regulations, most of the current implementing rules would have to be adapted and/or new ones adopted; for instance in the domains of airworthiness, operations, ATM/ANS, environment, aerodromes, personnel licensing, etc. Since some of these operations will be unmanned, synergies with the drones regulations will also have to be further assessed.
This Roadmap summarises the findings of the Task Force as well as the reflection of the various services of the Agency, and presents them in the format of a pre-impact assessment, for delivery to the European Commission in order to support its decision on the follow-up of this file.

Due to the uncertain timeline for the commercial development of HAO in Europe, the Roadmap proposes a progressive approach, focusing initially – for the next 2 to 3 years - on preparatory actions such as studies, tests and demonstrators, supported for instance by the concept of regulatory sandboxes, in order to allow the first operations to take place, while learning from these to optimally design the future regulatory framework.

Proposed preparatory actions:

- Possible pre-application contracts with EASA to support industrial projects
- Development of special conditions for design approval in case of formal application

- Development of guidance on and support to regulatory/innovation sandbox tests for HAO
- Launch of scientific studies on HAO, e.g.:
    - Regular updates of HAO market/demand analysis
    - Study on CNS needs and capacities (incl. alternative means) in Higher Airspace
    - Study on the capacity of EUSST sensors to monitor traffic below 80 km
    - Study on the impact of high altitude on human health (pilots and crew)
    - Study on medical standards /requirements for crew and passengers at high altitude
    - Study on HAO spectrum needs
    - Study on the availability of MET and space weather forecast for HAO
    - Study on civ-mil collaboration in HAO
    - Study on societal acceptance of HAO
- Detailed analysis/screening of existing EU Basic Acts (SES + EASA BR) with regard to HAO
- Detailed regulatory gap analysis and impact assessments (safety, cyber, environmental)
- Gap analysis of other EU regulations on civil aviation (internal market)
- Monitoring/supporting the developments at global and ICAO level, promoting the EU approach
- Improving the EUSST service for its use by aviation/identify synergies with EUSST sensors capacity
- Liaising with the EU developments on STM
- Awareness raising and competence building in EASA and within the competent EU bodies
- Creation and maintenance of a network of EU HAO stakeholders for regulatory aspects of HAO
- Improvement of occurrence reporting on HAO
- Creation of a library on HAO (total system perspective, beyond ATM)

European Union Aviation Safety Agency

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1 Introduction

Industrial developments in Europe as well as operational demonstrations in third countries indicate that more Higher Airspace Operations (HAO) could bring in a new category of airspace users in the near future. The test launch in January 2023 of a Virgin Orbit air-launch-to-orbit operation from the UK could make orbital space operations a new reality for continental Europe. The recent overflight of the American continent by un-authorised balloons and objects has made the question of the applicable legal regime more acute.

Higher airspace (HA) is described as the volume of airspace typically above altitudes where the majority of air services[1] are provided today (typically FL 550) and where HAO are carried out[2].

One might see in the short to medium term HA operations performed by several different types of manned or unmanned vehicles with various flight profiles, such as balloons, airships, supersonic/hypersonic aircraft, suborbital vehicles, re-entry of vehicles, sounding rockets, etc., some of them flying or cruising in that airspace with others simply transiting through it. The Agency has already received some applications for airworthiness certification (mainly HAPS, High Altitude Platform Systems or Pseudo Satellites) and is regularly approached in the context of new industrial projects. In parallel, several suborbital operations took place in the US in 2021 and 2022[3] and their operators are considering future flights in Europe, encouraged by spaceport development projects in some EU Member States[4]. Finally, the recent adoption of a Joint Communication from the Commission and the High Representative on Space Traffic Management (STM)[5] highlights the close interaction between space and air traffic, during the launch and re-entry phases of space flights and calls for a coordinated approach.

Future operations in the higher airspace will be manned or unmanned and may pose safety risks when transiting through the current air operations in the airspace below the HA (i.e., below FL 550 or FL660) or when cruising in the HA. They may also entail a negative environmental impact, notably in terms of noise or emissions.

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[1] Including ATM/ANS

[2] Definition developed by the EASA HAO TF, as a preliminary description. In practice, the current civil aviation traffic does not fly above FL550.

[3] However with mishaps: SpaceShipTwo grounded by FAA on 2 September 2021 after the flight mishap on 11 July 2021, NewShepard grounded by FAA on 12 September 2022 after the mishap (booster explosion) on the same day

[4] E.g. A Norwegian spaceport at Andøya is currently under construction with first orbital launch due to take place this year.

[5] Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy to the European Parliament and the Council on an EU approach for Space Traffic Management of 15.02.22 (JOIN (2022) 4 final

As these operations do not yet exist in the EU airspace (except for scientific/weather stratospheric balloons[6], sounding rockets or military HALE RPAS transiting above Europe at FL550-FL600), the relevance of the existing regulatory framework has not been assessed yet. Such assessment needs to be done to identify potential regulatory gaps and propose regulatory options, if needed, to provide the necessary protection and safety, and environmental protection. It is a rare opportunity to assess and prepare the regulatory landscape, in advance of technological developments, as it also offers the potential to start from a blank page and devise innovative and disruptive solutions for this new kind of traffic.

This Roadmap is therefore a preparatory and preliminary step, aimed at identifying the (regulatory) issues around the development of HAO in the EU, collecting initial available information and data, notably from the work performed by the EASA Task Force on HAO, raising awareness and receiving initial stakeholders' feedback to support informed decision-making on the possible launch of an impact assessment and rulemaking task in 2023.

2 Issue analysis

2.1 Context

Apart from scientific stratospheric balloons, military HALE RPAS and sounding rockets, no higher airspace operations have taken place in the EU since the Concorde retired in 2003, unlike in third countries (e.g. in the US) and plans for the first operations have constantly been shifting. No specific HAO regulation is yet in place at EU level, while some EU members states have already developed national regulations. The SESAR JU/EUROCONTROL ECHO1 project and EASA TF on HAO are the first attempts to reach a common EU view and proposals on the subject.

2.1.1 EU level

European Commission

The Commission (DG MOVE) organised the European Higher Airspace Operations Symposium[7] in 2019, the first event of this kind in the EU, to take stock of the developments in the emerging domain of higher airspace operations and is managing a regular inter-service group with European Institutions and Agencies, concerned by HAO.

Recently, the Commission (DG DEFIS) and the High Representative[8] published a Joint Communication on Space Traffic Management (STM), the definition of which includes the launching and re-entry phases of space vehicles and therefore the crossing of the airspace, below and above FL550. STM may therefore impact the safety of air operations, in the lower and in the higher airspace.

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[6] Sounding rockets and stratospheric balloons have been launched from Northern Europe (SE, NO) for more than 50 years.

[7] https://www.eurocontrol.int/sites/default/files/2019-07/2019-04-09-ehao-symposium-conclusions.pdf

[8] Joint Communication to the Council and the European Parliament on "An EU Approach for Space Traffic Management -An EU contribution addressing a global challenge" JOIN(2022) 4 final of 15.02.2022

EASA

Following the Symposium organised by the European Commission in April 2019, DG MOVE mandated EASA in May 2019 to "*start preparatory actions for the definition of the regulatory framework […] and assess the work to be done in all areas of its competence, incl. on safety, security, environmental protection, taking due account of the interface with 'lower' airspace users and with space users*". This assessment should include the methodology and the resources considerations and be in accordance with the High-Level Principles listed in the conclusions of the 2019 European Higher Airspace Operations Symposium.

In October 2019, the EASA MAB agreed to create an informal Task Force of experts on HAO[9] to share experience among Member States and define basic principles for a European regulatory framework for HAO. The HAO TF, chaired by a Member State (IT) and supported by EASA for the Secretariat, was launched in November 2020 and met 20 times[10]. On the basis of the work of the TF, the Agency has developed the present Roadmap, as a pre-impact assessment of the HAO issue, in order to provide initial analysis and guidance to the EU regulator.

SESAR JU

In parallel to the mandate given to EASA, DG MOVE requested the SESAR JU to launch a research project under Horizon 2020 ("ECHO project")[11], managed by EUROCONTROL, to analyse the demand and produce a CONOPS by the end of 2022. The scope of the ECHO project focuses on the ATM/ANS aspects. The final results of the project have been presented during the 3rd workshop on 6-7 December 2022.

EU Member States

Some EU States have already experience in the launch of stratospheric balloons and sounding rockets (FR, SE, NO), experience in supersonic transport (FR), experience with the Loon project before its abandonment in January 2021 (with some balloons uncontrolled descents in FR FIRs generating dangerous situations in continental Europe or FR overseas), and some have already developed national legislation (IT) (See Annex 1).

2.1.2 ICAO level

Four European papers have been prepared on the subject:

- A paper on "*Emerging issues: operations above FL 600*" for the 13th Air Navigation Conference (2018);
- A paper on "*New entrants*" for the 40th Assembly (2019)[12] which led to Resolution A40-7 calling upon ICAO to consider the need for modifications to the ICAO provisions including, inter alia,

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[9] The Task Force has been tasked by the EASA MAB, following the EC mandate, "to do preparatory work and define principles for a potential future European regulatory framework for higher airspace operations in accordance with the High-Level Principles listed in the Conclusions of the EHAO Symposium "formally endorsed by the EC" (Ref. EASA HAO TF ToRs v3 of 16 Dec. 2021, and MAB 2020-02 of 29.06.2020, AI 10 WP/IP "Next steps on Higher Airspace Operations (HAO): setup of a task force")

[10] The TF counts 6 Members States (IT, FR, DE, FI, SE, NO), EDA and Eurocontrol as members; other Member States did not express interest or did not have sufficient resources to participate

[11] https://higherairspace.eu/echo-project/

[12] A40-WP86 – 26.7.19

the rules of the air, airspace dimensions, airspace classification, liability, licencing, environment and certification to accommodate UAS and higher airspace operations;

- A paper on "*Higher Airspace Operations*" for the 3rd ICAO High level Safety Conference (May 2021); the paper, which stressed the urgency for ICAO to organise a global dialogue on this subject, was on the list of European priorities but was not presented due to the cancellation of the Conference (Covid);
- A paper on "*Higher Airspace Operations*" for the Technical Committee of the 41st session of the ICAO Assembly (September/October 2022) calling ICAO to take action.

Despite these repeated requests, ICAO has not taken any dedicated action yet. The Secretariat of the ad hoc Space Learning Group (SLG) which had been looking since October 2014 at suborbital flights and interfaces between aviation and commercial space transportation (CST) and organised 3 joint ICAO-UNOOSA 'Space' symposiums in 2015, 2016 and 2017[13], has been dormant since the end of 2018, following the withdrawal of FAA-AST from the informal group. It seems that the Separation and Airspace Safety Panel (SASP) reflected in 2019 on some of the HAO aspects (balloon separation linked to the Loon project before its abandonment in January 2021). The ICAO Secretariat is still reflecting on the follow-up to provide to the recommendations adopted during the 41st session of the General Assembly in September/October 2022. The risk is that some States may, in the absence of global coordination, develop their own rules on HAO creating "de facto" standards, which may be difficult to modify and harmonise afterwards. The notion of "commercial space transport" and the potential competence of ICAO may have to be clarified as a pre-requisite.

2.2 Early descriptions/definitions of main elements of HAO

Due to the novelty of the HA vehicles and operations, **no clear descriptions existed in the EU before the HAO TF and the ECHO project,** and no binding/regulatory definitions either. It is not clear either whether existing rules on aviation are suitable for all HA operations and vehicles. Therefore, an assessment is needed and creating a common understanding of new concepts is an essential step. Both the ECHO project and the EASA HAO Task Force have proposed some descriptions/definitions of the new concepts, vehicles and operations related to HAO, including totally new terminology. The definitions adopted by the US and some EU Member States (e.g., Italy) in their legislation are a good basis for discussion.

However, these models/concepts would have to be analysed in the light of EU specificities and objectives, in particular in terms of safety level, environmental impact and cyber-security and any EU regulatory proposal would have to be validated ultimately by all EU Member States. Europe indeed offers specific characteristics that deserve specific responses (e.g., high density of population and air traffic, very high aviation safety standards, important aviation industry, ambition of Europe to keep a role as space power, need for EU autonomy, etc.).

Another difficulty lies in the fact that there is no agreement at global level on the **physical delineation between airspace and outer space** which makes it difficult to define whether some vehicles and

[13] Three ICAO-UNOOSA 'Space' symposiums: http://www.icao.int/meetings/space2015/Pages/default.aspx ; http://www.icao.int/meetings/space2016/Pages/default.aspx ; http://www.unoosa.org/oosa/en/ourwork/spacelaw/workshops/2017/icao-unoosa-symposium.html

operations are aviation or space related, by using this geographical/physical criteria ("spatialist approach"). The conventional and informal limit of 100 km is often referred to as separating air and space operations: some States have included it in their national legislation[14] but there is no consensus at global level. For the space community, space operations seem to relate to operations aimed at going to or placing an object in orbit, the lowest circular unpropelled orbit being at around 150 km altitude (at this altitude, a space object only makes a few 90-minute orbits before the drag and fast orbital decay makes it re-enter)[15].

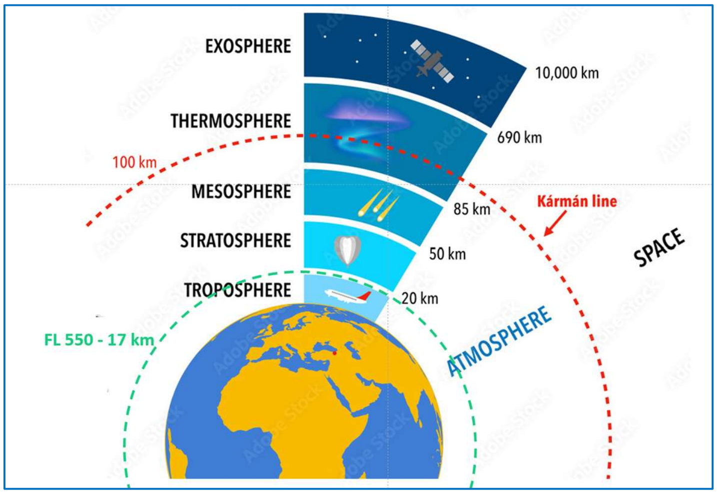

Fig. 1 – Representation of the airspace and outer space altitudes

The ICAO Legal Committee[16] and the UN COPUOS have suggested to look at the purpose or intent of the flight ('functionalist approach') to determine whether it is a space or aviation operation: flights which would be passing merely in transit through (sub)orbital space in the course of an earth-to-earth transportation would remain subject to air law.

Conclusion No 1

Even if some of the higher airspace operations may include transiting space launches or re-entries, they will take place principally in the airspace under the responsibility of States, and not in the outer or extra-atmospheric space.

In addition to air transport operations, space operations are transiting through the airspace and through the HA. Based on the work done in the ECHO project, the EASA Task Force on HAO has

[14] E.g. Australia, Denmark

[15] The new US Space Regulation Part-450 provides that no LCOLA (launch collision avoidance) analysis is needed for missions that do not exceed 150 km in altitude because orbital objects below this level are exceedingly sparse and usually are not present for long durations.

[16] ICAO Legal Committee LC/36 WP/3-2

identified 27 sub-categories of vehicles expected to be operating in the higher airspace in the future (see § 3).

Conclusion No 2
Interim definition of Higher Airspace Operations
Higher Airspace Operations can be, at this stage and for the purpose of this document, understood as relating to "*air transport operations carried out by various types of aircraft or air transport vehicle systems in the volume of the airspace above altitudes where the majority of air services*[17] *are provided today", i.*e. typically above FL550.

This definition and the other ones provided in this document (Annex 2) are only preliminary and indicative descriptions to facilitate the comprehension of the Roadmap but would have to be re-assessed in a regulatory development context. They **focus primarily on terms related to the aviation component of HAO, which may fall under the competence of the EU/EASA**. Other definitions related to Member States' competences in aviation or to space operations and vehicles have been developed by the EASA TF, but are not addressed in detail in this Roadmap. ICAO/EU definitions have been used where they exist (marked with*).

2.3 Opportunities of HAO for the EU

The air transport system is facing numerous challenges: digitalisation, more stringent environmental standards, growing complexity of systems and greater focus on competitiveness, for which HAO could provide opportunities.

- Environmental benefits:
  - Cheaper, more efficient and environmentally friendly alternative compared to space operations and applications (e.g., for communication, observation, research), potential to contribute to the sustainable development goals:
    - In contrast to a space mission, some HAO missions, like solar/fuel cell electric HAPS prototypes, can operate without rocket propulsion and fossil energy;
    - The option for slow manoeuvring comes with many advantages. It allows the usage of static lift at very low drag influence. Slow moving aircraft are able to manoeuvre usually without strong weather interference above the troposphere (at 8 to 15 km altitude). Controlled landing and re-usage of higher altitude vehicles is much easier than for space launchers, as the basic principles of aerodynamics are valid continuously for the entire flight. This helps saving fuel and allows more sustainable construction of the vehicle.
      - life-cycle assessments of projects could be envisaged, including the production, operational life and disposal (for the system and energy/fuel used):
  - Faster and possibly cleaner air transportation compared to today's aircraft (high speed transport) which could offer useful applications, i.e. for urgent transport of cargo or

[17] Including ATC

persons (also depends on the life-cycle assessment of the energy and fuel produced and used) ;

- New technology developments and innovative applications:
  - Spin-offs may be stimulated;
  - Opportunity for industrial deployment and jobs in Europe, through the manufacturing and operation of vehicles and ground infrastructures;
  - Opportunity for capacity building and development of European peripheric regions.
- Potential incubator for the future evolution of the current aviation system (e.g., including artificial intelligence towards a higher level of automation):
  - Possibly some synergies and commonalities with the U-Space / UTM concepts;
  - Opportunity to possibly establish seamless services in the European higher airspace;
  - Concepts of pan-European airspace operations might be applied in the higher airspace-and influence, if successful, the evolution of the current ATM system. HAO could become a prototype/precursor for a real Single and seamless European Sky (respecting the States' roles, national security, and sovereignty prerogatives
- Contribution to the EU strategic autonomy and security in the Near Space, i.e. the area just below outer space, as well as access to Space.

Conclusion No 3

HAO offers the opportunity to test new concepts and approaches and to design from the start an innovative and possibly disruptive aviation system in the higher airspace, that could ultimately influence the modernisation of the current aviation system in the airspace below FL 550.

2.4 Affected and interested stakeholders and interface with other activities

The main stakeholders affected by these new operations are notably:

- **The aviation industry**

EU manufacturing industry (aircraft, ATM/ANS systems), R&D organisations, aircraft operators

Several EU manufacturers are developing HAO-related projects. Some of the future HA operations have the potential to create new markets and jobs and the related innovations, notably in the area of design, propulsion, solar power generation, aerothermal structural capability, and can trigger spin-offs benefitting the whole EU aviation sector. However, the absence of indications/visibility on future regulatory requirements at EU level, notably on future flight standards, complicates the design and development of HAO vehicles, ground and CNS infrastructure. Furthermore, the EU industry is exposed to advanced competitors from 3rd countries, some of them intending to fly to/from Europe. A regulatory level-playing field ensuring fair competition, within the EU as well as between the EU and the rest of the world, and safe operations in the EU would therefore be needed.

- **ATM/ANS service providers and aerodromes/stratoport operators**

National ATM/ANS providers, incl. CNS providers, Network Manager, aerodrome and stratoport operators

The ATM/ANS sector will be affected in two ways:

- It will have to accommodate the transiting traffic of HAO and its interaction with conventional air traffic at lower altitudes (civil-military, commercial and non-commercial operations, comprising transport, specialised and experimental ones); the few HAO or space launches taking place today generate little disturbance because they are limited in number, take place from remote locations and therefore are segregated from air traffic. In the future, one may see a growing number of HAO or space launches and re-entries of re-usable vehicles, taking off from inland areas with higher density of population and air traffic. More frequent segregation or integration will be necessary.
- It will have to design new solutions, to ensure an orderly and safe traffic at higher altitude, since traditional ATM/ANS facilities and services may not be sufficiently adapted to these new operations (e.g. CNS). For instance, ADS-B surveillance is not reliable for aircraft travelling faster than 1850 km/h. In this sense, this new field offers the opportunity to think unconventionally and devise innovative approaches to air traffic.

Furthermore, some airports (when used also for co-located HAO) would be impacted if used for both conventional aviation and HAO since they would have to accommodate different types of take-off/landing operations and potentially have to meet different requirements. Finally, the future stratoport operators will be directly concerned.

- **Future crew, participants and passengers**

  Pilots and crew, passengers/consumers

  Some HAO vehicles will embark crew, participants and passengers. The low level of maturity of the HAO concepts and technologies and possibly some harder physiological conditions for some flights (e.g. high and fast acceleration variations) increase the safety and casualties' risks. The competences required for the crew will have to be defined as well as the medical requirements for crew and, possibly, for participants and passengers., which would constitute a precedent in civil aviation.

  More generally, the level of protection required for participants and passengers will also have to be defined (e.g. should the passenger be free to fly at their own risk, after having signed a liability disclaimer, or should safety targets be imposed on these operations?), also taking into account the issue of medical fitness and potential medical requirements.

  The ECHO Project and the HAO TF have identified the separate notion of 'participant' to designate the person on board an HA vehicle who is performing a mission or task other than those of the crew, against remuneration (e.g. scientific experiments). This category may require separate requirements.

- **Military and governmental stakeholders**

  National defence, Civil-military coordination forums, EDA, NATO

  Civil air transport is a shared competence at EU level and therefore Member States remain competent for some aspects of it. They are also competent for the regulatory framework regarding space activities.

Part of the HAO operations will be conducted for military or governmental purposes, therefore requiring coordination with civil ones, both during the transit in the 'lower airspace' and in the higher airspace. State activities include military, customs, police, search and rescue, firefighting, border control, coastguard or similar activities or services under the control and responsibility of a Member State.

- **Third parties on the ground and in the airspace**
  Conventional aircraft operators, civil protection organisations and services, maritime safety authorities
  The risk of damage on the ground (sea and land) exists also with HAO, possibly amplified by the larger ground risk footprint for take-off and landing, especially for unpowered glide-landing, preventing any go-around option. Also, the risk might be higher due to the limited manoeuvrability, predictability, reliability or altitude keeping performances of some HA vehicles (for both nominal and non-nominal cases).
  In the controlled airspace below HA, the risk of collision with conventional aviation is also increased, due to the specific size, propulsion and/or flight profiles of the HAO vehicles, the manoeuvrability predictability, reliability or altitude keeping performances of some of them being limited (for both nominal and non-nominal cases).

- **The space community**
  National and European space agencies, the EU-SST consortium and various bodies working on the STM subject, space launchers manufacturers and operators
  Close coordination with space activities needs to be ensured. In particular, as higher airspace operations may include space vehicle or systems transiting through the airspace and the higher airspace and interfacing with the airspace and higher airspace operations, roles and responsibilities of the traffic management of such vehicles/systems in higher airspace need to be unambiguously defined between ATM and STM.
  Moreover, as most re-entering space debris usually break up and burn at around 80 to 70 km altitude, these could represent a threat for those operations able to fly above these altitudes. Given their increasing frequency, adequate cooperation on this risk needs to be envisaged, especially for large debris re-entries under a controlled re-entry trajectory.
  Furthermore, the sharing of responsibilities for the operation of 'spaceports' (either orbital or multi-purpose orbital/suborbital) and the related technical requirements need to be defined between HAO and space domains.
  Finally, efficient collaboration with national space authorities and agencies, and the European space agencies (e.g. national, ESA, EUSPA) needs to be assured.

Conclusion No 4

HAO developments will interest/impact the traditional aviation stakeholders, as well as new stakeholders notably the space community. The military community has a particular interest and should be closely associated to these developments.

2.5 Problem drivers and evolution

The problem analysis is made difficult due to two factors of uncertainty:

- **Uncertainty on the demand timeline**: knowledge of the timeline for the introduction of HAO in the EU is a critical pre-requisite to the problem analysis. The demand of HAO traffic in the EU is very limited so far. According to the ECHO Comprehensive Demand Analysis, a fast-developing need has to be expected in the upcoming years, already before 2030. However, other sources on the contrary, consider that "*significant changes to the number of users and type of aircraft operating above FL600*" should not be expected in the short-term[18]. It is therefore difficult to get a clear and stable picture of the future demand and take, on this basis, a decision on the opportunity to regulate or not these new operations at EU level in the very short term.
  If the demand remains low in the coming 10 years, the few operations could possibly be accommodated within the current regulatory framework, applying exceptions and segregation where needed. Furthermore, as only very few users exist at this stage, their expectations may not be representative of the future industry needs, and defining the rules with these industry partners could entail the risk of limiting future potential industrial developments. This would support a decision to postpone to a later stage the development of a specific regulatory framework for HAO.
  On the contrary, if the demand develops at a fast pace in the coming years, it might become necessary to adopt or adapt regulations to:
  - Support EU industry developments by providing a clear frame and legal certainty, essential for investing into new technology;
  - Have a framework ready and in place when the first operations take place, in particular for operators from the EU and for operators from third countries willing to fly in the EU airspace;
  - Harmonise throughout the EU and avoid regulatory fragmentation due to national initiatives in domains under the EU competence;
  - Influence the development of global standards at ICAO level, notably for the definition of safety and environmental protection levels.

- **Large diversity of HAO**: the types of operations expected in the higher airspace are multiple and very different. They trigger several issues, relating to the different categories of vehicles, different purposes/missions, various speeds, energies (risks), predictability, manoeuvrability and altitudes, different phases of the flight (lower airspace, higher airspace, outer space for some of them) and transition between different airspaces, different legal regimes (aviation/space), respective competences of MS and the EU (see Part 3). While some of these operations/vehicles may be covered by existing EU regulations on civil aviation (e.g. some HAPS), others would not be. There is therefore a risk of difference of treatment and

[18] "Emerging Aviation Technologies – Preliminary analysis – Operations above FL600

discrimination among the higher airspace users. Bringing these different needs together and finding a balanced set of rules, respecting every current and potential future operation use-case, could be difficult and take time, but ensuring a regulatory level-playing field addressing all categories of HA users appears necessary (e.g. for access to market, social acceptance, etc.).

Conclusion No 5
A proper and detailed assessment of the risks posed by HAO is made difficult at this stage, due to several uncertainties, such as the large diversity of vehicles and the timeline for the introduction of these operations, notably the commercial ones. More knowledge is needed by the regulator.

2.5.1 Problem driver No 1 – The risks created by HAO

The risks triggered by the development of HA vehicles and operations will have to be analysed.

2.5.1.1 Safety risks

Stakeholders interested in HAO have different views on the target level of safety and possible safety requirements that should be imposed on these operations. These views are justified by the necessity to support an emerging industry or, on the contrary, by the need to impose requirements as severe as those for conventional aviation to preserve the industrial developments from failures and casualties. The safety requirements may vary according to the presence or not of passengers/participants on board, the place of launch/take-off, the phase of the flight, the flight pattern and technology used. It would therefore appear necessary to analyse the safety risks of the operations and for the EU to promote and adopt a joint EU approach on this.
The safety risks of HAO will have to be assessed and mitigated vis-à-vis the other aviation traffic, the possible occupants of the vehicles/aircraft and the persons and facilities on the ground (land or sea).

The safety risks vis-à-vis **other aviation traffic** may vary according to the different phases of flight:

- In the transiting phase from the ground to higher airspace and from higher airspace to the ground (i.e. between ground and FL550), the HA vehicles will interfere with the currently existing civil and military aviation traffic. The impact of their novel technological characteristics on conventional air traffic needs to be determined, taking into consideration their flight patterns, e.g. very slow or very high speed, their manoeuvrability, specificity and complexity of the European airspace, as well as the weight and nature of their payloads;
    - the Task Force was of the opinion that the safety objectives/targets to be applied to HAO should be the same as for general aviation complex aircraft (1E-5 to 1E-4).
    - the Agency rather considers that the safety objectives should be set in such a way as to ensure a safety continuum with commercial aircraft and operations. In any event, the objectives would have to be analysed and set on a case-by-case basis, for each category; the same reasoning would apply to unmanned HAO; in this context, an approach inspired by the SORA methodology used for drones could be considered.
- In their cruising phase, the risks may be different and lower due to the larger volume of airspace and fewer movements; even though the HA vehicles may present very different

characteristics, the risk of collision between them would probably be lower than in the currently controlled airspace at lower altitude.

The safety hazards vis-à-vis vehicle/aircraft **occupants** are the same whatever their status. The ensuing risks will be higher than the risks of conventional aviation, notably due to the high speed (above Mach 1) and high acceleration, radiation exposure and the risk of accidents caused by immature technology on which operators and regulators have little experience. However the level of protection and potential liability could vary. For HA vehicles/aircraft with persons on board, the EASA TF is proposing to distinguish:

- The crew, specifically trained and remunerated for the tasks onboard the HA vehicle/aircraft;
- The participants, contributing to a mission or tasks other that the conduct of the flight, possibly remunerated and partly trained;
- The passengers, perhaps partly trained but paying for a service.

The acceptable maximum safety risks to **third persons and properties on the ground** would also have to be set and mitigated, taking into account the technical characteristics and performance of the different categories of HAO, their launching and landing patterns, as well as the specificity of the densely populated European territory. This also links with the establishment of HAO aerodromes/stratoports/spaceports and the land use around them. The measures to mitigate those risks will have to ensure that the acceptable maximum safety risks to third persons on the ground caused by HAO should not be higher than those of current conventional aviation.

If nothing is done, initial HAO would have to be conducted as experimental or scientific tests flights on an ad hoc basis, limited in number (e.g. max. 10 or 20 operations per year) and be segregated from the rest of the traffic with the risk of disrupting it as the number of flights would increase. This could however ultimately impair the development of HAO in Europe and would not fully protect against safety risks.
The objective of the EU action in this regard should be to allow the progressive introduction and integration of HAO without jeopardizing the current safety levels of European aviation.

2.5.1.2 Environmental risks

HAO may also pose increased environmental risks. They would potentially increase the overall aviation environmental impact in terms of emissions and noise, but could also in some cases reduce it. This impact may vary according to the various categories of HAO, some of which being equipped with powerful propulsion systems based on fossil fuels or fuels which require high energy to produce (e.g. rocket propulsion), potentially much noisier and more polluting than those of conventional aviation. The very high speed of some of these vehicles will raise the issue of sonic booms. Furthermore, the impact of high altitude flights on the ozone layer will have to be assessed.
On the other hand, several projects for HA vehicles are also looking at new and clean propulsion technologies, such as solar power and hydrogen (if produced with low environmental impact), thus having the potential to drive change towards a greener aviation.

If nothing is done, there is a risk that the efforts towards the greening of aviation become sub-optimal. There is also a risk of discrimination between airspace users as well as a risk of societal non-acceptance of HAO.

The objective of the EU action in this regard should be to allow the progressive introduction and integration of HAO without jeopardizing the environmental objectives of European aviation.

2.5.1.3 Security and cyber-security risks

HAO will fly at new altitudes that may incur new security and cyber-security risks, linked for instance to the fact that they will not be visible from the ground and possibly by conventional aviation radars. These high altitudes will also potentially require new CNS systems, based on space-based services provided through digital links. In addition, many HAO will be unmanned, with digital C2 links, increasing their vulnerability to cyber-threats. Finally, the very high speed and or very high altitude of some HAO will make them difficult to intercept.
If nothing is done, HAO could create new security threats and the objective should be to allow the development of HAO while identifying and limiting those risks.

2.5.2 Problem driver No 2 - Multiple competences

HAO involves competences related to civil aviation, aviation safety, defence/military, State security, aviation security and cybersecurity, sustainability, airspace management, space activities and, as a consequence, the definition of the competent authority for the regulation and oversight of HAO is not easy (see also Part 3). With the increase of space traffic transiting through the airspace and the future Higher Airspace, the competences at national and EU level might become even more intertwined. States have the full competence to organise their respective sovereign airspaces.
There is a need to clarify the boundaries of the respective legal and regulatory competences of the Member States and of the EU in this field.

2.5.3 Problem driver No 3 - Need for interoperability at regional and global level and common approach for security and military aspects

HAO may be cross-border with a large range of action, requiring efficient and rapid coordination between aviation authorities at national, regional and trans-continental level. There is a need to ensure, at least at EU regional level, common rules on HAO, at least for the aviation part and if possible, for the hybrid operations upon further analysis and agreement with Member States. But ultimately, a global approach through ICAO, would be needed.
For the space vehicles/operations, the competence is with Member States, and discussions and negotiations are ongoing in international for a such as COPUOS and the UN 4th Committee. However, nothing would prevent EU Member States to get together on a voluntary basis and align on a common European approach.

The military requirements will have to be duly taken into account in the proposed solutions in order not to impair future military operations and strategic interest in the HA. HAO, during their climb or descent phases, will have also to be interoperable with military operations conducted below the HA in order to continue to preserve national security and defence interests.
If nothing is done, there is a risk of a fragmented uncoordinated approach among Member States, leading to different safety and security levels and unfair competition. Air traffic can be managed in an efficient, coordinated, and seamless way, even if the airspace organisation identifies some boundaries The objective of the EU in this regard should be to harmonise as much as possible the framework for HAO in the EU, at least for the elements under its legal competence. For hybrid, space, state and military operations, where the Member States remain competent, the objective of the EU should be to facilitate the integration/accommodation of these operations into the civil aviation operations and airspace, as well as to support a common approach by EU Member States in international forums.

Conclusion No 6

The regulator would have to address a number of problems/issues related to HAO, in particular:
- Prevent safety, security and environmental risks of these operations
- Clarify the respective competences, in a context of parallel and shared competences
- Ensure sufficient interoperability at regional and global level

3 EU competence to act and subsidiarity

It is important to determine first whether the EU is competent in the HAO field and to which extent.

The Task Force and its sub-group on 'space-airspace' (ASOI-SG) analysed the interface between space operations and air transport operations, to propose an initial guidance on the respective competences of Member States and of the EU.
To this effect, the EASA TF and its sub-group identified 27 types of future HAO vehicles, as known today, and analysed each of them in the light of various criteria, such as the purpose of the flight, the compliance with the definition of aircraft, etc. In addition, and given the difficulty to adopt a 'spatialist approach' based on the vertical limits of the airspace, EASA suggests to adopt the functionalist approach, which considers that flights which are performed principally in the airspace, even if passing briefly in transit through orbital space, in the course of an Earth to Earth flight remain subject to air law[19].
The analysis shows that not all vehicles and operations that will take place in the higher airspace fall under the scope of the Chicago Convention which is applicable only to civil aircraft. This is the case for space vehicles systems, orbital operations, sounding rockets, launches to orbit (re-usable partly, fully or expandable) and vehicle re-entries from orbit.

[19] As explained in conclusions of ICAO Legal Committee 36

Keeping in mind the shared competences in air transport (art. 4.2 and 100.2) and the parallel competences in space matters (art. 4.3 and 189) stated in the TFEU, the sub-group then analysed the respective competences of the Member States and of the EU to regulate civil aviation safety.

Under the current EASA BR, the EU/EASA is notably competent to regulate the design, production and maintenance of **aircraft**, their **engines** and their equipment, the operation of **aircraft**, the design, operation and maintenance of **aerodromes**, the provision of **ATM/ANS**, the design of airspace structure in the Single European Sky, and the **personnel** and organisations involved in all these activities. This competence excludes some categories of aircraft, such as the military/state aircraft and the civil aircraft presenting low safety risks, and aerodromes such as the military/state aerodromes, which remain under the responsibility of Member States.

All vehicles systems which do not correspond to the definition of aircraft and their operations, as well as all ground infrastructure which do not fall under the applicability of Reg. EU 139/2014 EASA are therefore, for the time being, under the competence of Member States.

The SES Regulations apply to **general air traffic** (i.e. movement of civil aircraft) and military aircraft following civil rules) operations. **The regulation traffic other than GAT in the airspace is the responsibility of Member States**.

As a result, it can be concluded that the following categories of aircraft and their operation may fall under the current EU/EASA competence (within the limits of the applicable regulations) and that an assessment of the regulatory needs and possible future EU framework applicable to these aircraft and their operations is needed:

	Categories	Possible Sub-categories	
HAO VEHICLES & OPERATIONS CATEGORIES	HAPS	LTA balloon, unoccupied, scientific/weather stratospheric, non-commercial, long duration, pressurized, open or Z-controlled balloons (e.g. CNES weather balloons, since 1961)	
		LTA balloon, unoccupied, commercial, nobody onboard, long duration, for surveillance, telecom. (e.g. Sceye, defunct Loon project)	
		LTA balloon, with pilots and pax tourists, few hours (e.g. Bloon, Zephalto, Stratoflight, WorldView, SpacePerspective)	
		MLTA airship, unoccupied, motorized solar electric, for surveillance, telecom. (e.g. Stratobus, Stratosyst)	
		MHTA airplane, unoccupied, slow and light, motorized solar, for surveillance, telecom. (e.g. Zephyr, Sunglider, Stratostreamer)	
		MHTA airplane, unoccupied, subsonic Mach0.6-0.9, turbofan, remotely piloted (ICAO RPAS certified category extrapolated to HA)	
	Launch to Orbit	Air launch to orbit (horizontal)	From airplane, expendable rocket (Pegasus, Virgin Orbit)
			From airplane, reusable rocket (Dark space)
			From balloon, expendable (Bloostar)
			From airship
		Direct launch to orbit	VTO expendable rocket (Ariane-5)
			VTOL reusable rocket (Falcon-9)
			HTOL reusable spaceplane (SSTO)
			VTOHL reusable spaceplane
	A-A suborbital	Direct launch to suborbit	Sounding rocket, vertical (Maxus @Kiruna)
			VTOL reusable rocket (NewShepard)
			HTOL spaceplane future certified generation, air law (e.g. ArianeGroup 'SpacePlane' project)
		Air launch to suborbit	HL reusable air-launched spaceplane, not certified (SS2)
			HL reusable air launched spaceplane, future certified generation, air law (VSH)
	A-B suborbital	VTOL reusable rocket (Starship E2E suborbital version)	
		HTOL reusable spaceplane, single stage to suborbit	
		VTOHL reusable spaceplane (Falcon-XX [certified], SpaceLiner, DreamChaser), with booster for vertical TO	
	A-B high speed, trans-atmospheric, air-breathing	Supersonic A-B transport airplane, air-breathing propulsion	
		Hypersonic A-B transport airplane, air-breathing propulsion	
	Reentry from orbit	Vertical hard landing inlcuding the use of parachute (capsule)	
		Vertical retro-propulsion landing (capsule)	
		Horizontal landing (e.g. ESA SpaceRider, Sierra Space Dream Chaser)	

Fig. 2 - Categories of HAO operations and vehicles iidentified by the Task Force – In blue, operations possibly subject to air law and EU competence; in blue strikethrough, hybrid operations for which further discussion is needed.

Other vehicles present hybrid characteristics, e.g. during the successive phases of flight, combining boosters at take-off and aircraft characteristics when landing, or the air-launch-to orbit systems, where launches are performed in the air from conventional air carriers. It is unclear whether these carriers are cargo aircraft, or an element of a space launch system[20]. For these hybrid vehicles and their operations, a deeper assessment/study would be needed to determine the applicable legal regime and resolve potential conflicts of laws, keeping in mind the need to ensure safety in the airspace. The Roadmap therefore does not address the regulatory framework for hybrid vehicles and operations, which should be part of a separate and second stage assessment with Member States and the space community, based on further studies. It does not address either space vehicles or operations, with the exception of their transit into the airspace (see § 4.4 below).

[20] See Liability Convention on International Liability for damages caused by space objects, 1971, Art. 1 "The term 'space object' includes component parts, as well as its launch vehicle and parts thereof".

Conclusion No 7

Some of the HA vehicles will qualify as aircraft and their operations may be governed by civil aviation regulations: this will be the case at least for HAPS, supersonic and hypersonic aircraft. The EU is therefore competent already today to regulate these operations, within the limits of the current texts. For the time being, space operations remain under the responsibility and competence of Member States. Further assessment is needed for vehicles and operations of a hybrid nature.

For the HAO aircraft and operations under the EU competence, multiple domains of the aviation sector will have to be looked at, e.g. safety, environment, security, rights of traffic, market access, aircraft registration and leasing, operating licenses of air carriers, international and bilateral relations, personnel, airports, passenger's protection, transport of dangerous goods, etc.

This Roadmap focuses, **as an initial step,** on the **civil aviation safety and environmental aspects of the current EU competences**. The Commission is invited to assess the other aspects of HAO related notably to the internal market regulations.

4 Expected impact on the EU aviation regulatory framework

The following sections (§4.1 to 4.10) provide a general overview of the anticipated impact of **HAO aircraft and operations** falling under the regulatory competence of the EU/EASA on each domain of the EU regulatory framework applicable to aviation safety and sustainability. The EU total aviation safety system approach, in line with the EASA Basic Regulation, requires to review all the elements necessary to allow for safe and sustainable HAO, applying a comprehensive approach.

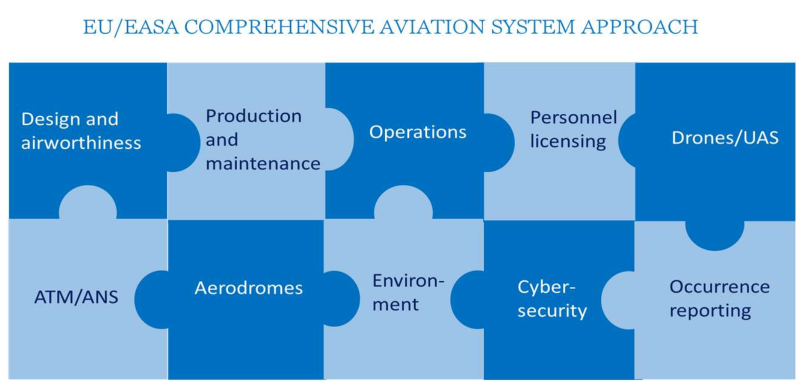

Fig 3 - EASA total system approach

Timeline issue

As already identified in § 2.5, the timeline for the deployment of HAO in the EU is uncertain, and so is the timeline for undertaking regulatory actions at EU level. The certification of a new type of aircraft may take 3 to 5 years. The preparation and adoption of a new implementing or delegated regulation, or an amendment to an existing one, takes in average around 3 years. Only one application for certification of an HAO aircraft is pending at EASA for the time being and it is unlikely that multiple civil or commercial operations of HAO aircraft, when certified, will take place in the EU airspace in the immediate future. Some foreign HA operators could consider flying in the EU, but the foreign certification of their vehicles, if they are considered as aircraft, would need to be first achieved in their country of origin and then be validated by EASA, which may take a few years. The possible operation of hybrid or space vehicles would fall under the responsibility of the Member State(s) concerned, with the Network Manager being possibly involved at strategic or pre-tactical stages to re-direct the traffic impacted by the temporary airspace segregation.

4.1 Design

Field of application / principles

- According to Art. 11 of Regulation (EU) 2018/1139, before a newly developed aircraft design may enter into operation, it must obtain a **type certificate** from the responsible aviation regulatory authority. Since 2003, EASA is responsible for the certification of aircraft in the EU and for some European non-EU Countries. This certificate testifies that the type of aircraft meets the safety requirements set by the EU. Changes to that design and repair designs shall also be subject to certification and shall result in the issuance of a certificate of changes and repair.
  Vehicles or systems, meeting the definition of aircraft, and related changes and repair designs, intended to be operated in higher airspace, will in principle need to undergo a similar process.
  Existing Certification Specifications (e.g. CS-25 Large Aeroplanes, CS-31 Balloons) may be used to demonstrate compliance of some HAO designs with the relevant essential requirements set out in Regulation (EU) 2018/1139.
  Furthermore, in accordance with Commission Regulation (EU) 748/2012, the Agency shall prescribe special detailed technical specifications, named **'special conditions'**, for a product if the related certification specifications do not contain adequate or appropriate safety standards for the product, because, among others, the product has novel or unusual design features relative to the design. Should new HAO aircraft designs require/apply for certification for which the existing certification specifications do not apply, the Agency would have to develop ad hoc 'special conditions'; this is usually achieved in coordination with the applicant, under an Innovation Partnership Contract (IPC) or a TAC (Technical Advice Contract).
  Regarding certification of foreign products (called validation), EASA has the possibility to have a specific relationship with other certification authorities, called Bilateral Aviation Safety Agreement (BASA), which is a treaty between the EU and another country, overruling Commission Regulation (EU) 748/2012 if needed; at the level of authorities, it is translated into the Technical Implementation Procedures (TIP). Currently, bilaterals are in place with US, Canada, Brazil, China, Japan and the UK.
  Taking as an example the case of the TIP with the US (EASA-FAA TIP), foreign product approvals can be either automatically accepted by EASA, or require a streamlined (administrative) validation, or require a technical validation based on the classification of the design to be validated. HAO aircraft will be subject to these provisions.
- According to Commission Regulation (EU) 748/2012, EU **organisations that design** aircraft, changes to aircraft, repairs of aircraft, and parts and appliances need to fulfil the requirements

as defined in Annex 1 ("Part 21"). Such organisations need to demonstrate that they have the right organisation, procedures, competencies and resources.

Similarly, organisations intended to design vehicles or systems, meeting the definition of aircraft to be operated in higher airspace, changes to these vehicles or systems, repairs of these vehicles or systems, and parts and appliances will need to fulfil similar requirements.

- Finally, with regards to **continuing airworthiness**, in accordance with Basic Regulation (EU) 2018/1139 Article 77 (1), EASA is responsible for fulfilling the State of Design responsibilities of its Member States. Pursuant to Article 77 (1)(h) of the Basic Regulation, EASA shall react without undue delay to a safety or security problem and issue and disseminate the applicable mandatory information. Such mandatory information is issued in the form of Airworthiness Directives (ADs), as defined in Initial Airworthiness Regulation (EU) 748/2012 Annex I; in accordance with Continuing Airworthiness Regulation (EC)1321/2014 Annex I (Part-M), the aircraft continuing airworthiness shall be ensured by the accomplishment of any applicable AD. Consequently, no person may operate an aircraft to which an AD applies, except in accordance with the requirements of that AD. Similar continuing airworthiness provisions will need to be applied to vehicles or systems meeting the definition of aircraft to be operated in higher airspace.

However, Annex I to the EASA Basic Regulation excludes from the scope of its application manned aircraft specifically designed or modified for research, experimental or scientific purposes, and likely to be produced in very limited numbers.

Challenges

The main challenges will be:

- Defining whether new HAO vehicles are aircraft or not.
- Defining whether (and when) the HAO vehicle qualifying as an aircraft will be designed and produced for research, experimental, scientific or commercial purposes, whether it will be manned or unmanned and in which quantity it will be produced.
- Defining whether the existing certification specifications can apply to this new aircraft, or whether there will be the need to develop special conditions.
- EU HAO aircraft design organisations obtaining a DOA, which could require significant amount of time (3-5 years).

Recommended actions

→ For HAO vehicles qualifying as aircraft under the scope of the EU regulations , being produced in sufficient numbers and for which existing certification specifications apply, no particular action will be needed at EU level, as current regulations will apply as they are.

→ For HAO vehicles qualifying as UAS under the EU regulations[21], in principle existing and upcoming certification specifications for the specific and certified category of UAS will apply.

→ For HAO vehicles qualifying as aircraft under the scope of the EU regulations which do not fall in the scope of existing certification specifications, special conditions would have to be developed on an ad hoc basis.

[21] Art. 3(30) EASA Basic Regulation EU 2018/1139: "unmanned aircraft' means any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board".

→ For HAO vehicles qualifying as aircraft under the scope of EU regulations but being designed and produced in limited quantity for research, scientific or experimental purpose, they will be considered in the perimeter of Annex I of Regulation (EU) 2018/1139, and hence in the remit of each NAA's State of Registry. The concept of 'regulatory sandbox' could be applied to these vehicles, and EASA could support the Member States by providing guidance on regulatory sandboxes and assisting with the tests, as necessary. It is to be noted that the exceptions provided for in Annex 1 to the EASA BR do not apply to unmanned aircraft, which remain subject to EU rules even for experimental or scientific flights.

→ Develop guidance material on 'regulatory sandboxes'.

→ For HAO vehicles with a hybrid nature, a further assessment on the need to apply similar requirements would be needed, before possibly extending partially the scope of the EASA regulations mentioned above.

4.2 Production and maintenance

Field of application / principles

Once a HAO design is approved (refer to 4.1), a production organisation would be tasked to manufacture and release the vehicle and its parts in conformity with the approved design data, while management/maintenance organisations would be in charge of the continuing airworthiness (respectively Regulations 748/2012 and 1321/2014).

Challenges

- Currently, the EU framework imposes that the aircraft must be 'registered' in one of the EU Member States to fall under the continuing airworthiness regulations; while the usual principles will apply for HAO aircraft (rules for registration are defined at the national level), it is unclear whether the non-aircraft vehicles would have to be registered and how (possibly under national space law).
- It is likely that the production of HAO aircraft will happen in very small series, if not unique. While EASA has developed rules for small production series, the basic assumption was that the risk posed by such aircraft developed in small series was limited (General Aviation, leisure, etc). The risk caused by HAO aircraft would have to be assessed in order to determine whether these rules would be applicable to these aircraft. In case they cannot apply, possibly specific rules for HAO aircraft would need to be developed.
- There would be a need to ensure that the first (and potentially unique) vehicle is manufactured in a controlled environment, while it has been customary in aviation to manufacture 'Development aircraft' as technological readiness demonstrators outside of a controlled environment. The process to become an 'approved organisation' should precede the manufacturing of the first vehicle. This is the case for well-established organisations, but is usually not the case for new entrants in the market. Therefore, the 'declared' process, as introduced for the lower end in Part 21 Light, would probably not be applicable due to the criticality and risks posed by such vehicles.
- New designs (engines, flight controls, materials for structures, space radiation protections, protective devices, etc.), new technologies (like the massive use of health monitoring/predictive maintenance concepts) as well as new types of operations (especially

in terms of environmental impacts and duration of flights) are also likely to impact the maintenance of the vehicles and would have to be studied thoroughly.

Recommended actions

→ Assess the risk posed by HAO aircraft to determine the applicability of EASA rules for small production series and possibly update or develop specific rules for HAO aircraft.

→ Assess whether hybrid HAO vehicles need to be subject to EASA/EU requirements on production and maintenance.

4.3 Operations

Field of application / principles

It is assumed that potential applications of HAO aircraft in air operations would fall in all the operations types existing today, as per EU rules for Air Operations (EU) 965/2012[22]:

- Commercial air transport (passengers and cargo) (CAT)
- Non-commercial operations (NCC, assuming that all 'xxx-craft' used in HAO will be complex
- Specialised operations (SPO), i.e. operations that have a purpose other than the simple transport of people and goods

Moreover, HAO will extend the current operational envelope and the kind of operations conducted, especially in the SPO field.

Challenges

Manned and unmanned operations are substantially different. Today the first ones are regulated in the Air OPS Regulation, the latter in the Drone Regulations. The following assessment is done for manned HAO only. For unmanned, please refer to § 4.7.

Today, the Competent Authority to certify and oversee operators may be a State (by means of an entity designed by the State) or EASA (for Third Country Operators and EASA AOCs). A similar scheme may be envisaged provided that EASA and MS competencies are similar as with conventional air operations. An operator having a certificate or a declaration in an EU State (or with EASA), as it is the case today for normal operations, would remain under the authority of its CA even when doing HAO, but it cannot be excluded that when entering into (or returning from outer space) some other constraints will be introduced (i.e., acceptance or authorization of more States, joint oversight, etc.). The current air operations rules are not fit for transitions to/from airspace/outer space.

Also HAO at very high flight levels will require specific equipment, crew qualification and training, flight time limitations, operating limitations, operating procedures (normal, abnormal, emergency), requirements on performance, that will have to de defined for each category of HAO aircraft.

Another important discriminant is the nature of the operation, i.e. commercial or not commercial, commercial rules being significantly more protective for the transport of passengers compared to non-commercial rules.

[22] This Regulation does not apply to airship and to some balloons (e.g. air gas)

Recommended actions

It would have to be assessed whether the EU rules for Air Operations (Reg. EU 965/2012) would need to be changed:

→ The scope of the Air OPS Regulation may have to be extended to the intended 'xxx-craft' categories, type of operations and operational envelope (these aspects have a cross-domain impact). Interfaces with other Regulations need also to be addressed (ATM/ANS, IAW/CAW, ADR, FCL).

→ The competent authorities may have to be identified and the relevant authority requirements updated to include new competencies and operator certification/approvals and oversight of new operations.

→ The organisation requirements may have to be updated to include requirements for certification / declarations / approvals, requirements for the operator's organisation and management system (SMS), personnel qualification and training, flight time limitations.

→ The technical requirements for air operations may have to be updated to include changes as necessary at least in: equipment, operating limitations, operating procedures (normal, abnormal, emergency), performance, special approvals.

4.4 Air Traffic Management / Air Navigation Services

Field of application / principles

The provision of air traffic management and air navigation services (ATM/ANS) is regulated in the EU by the SES Regulations and the EASA Basic regulation and their implementing rules, in particular Regulation (EU) 373/2017 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight. The 'conventional' ATM/ANS services and functions in the airspace currently controlled, include the following:

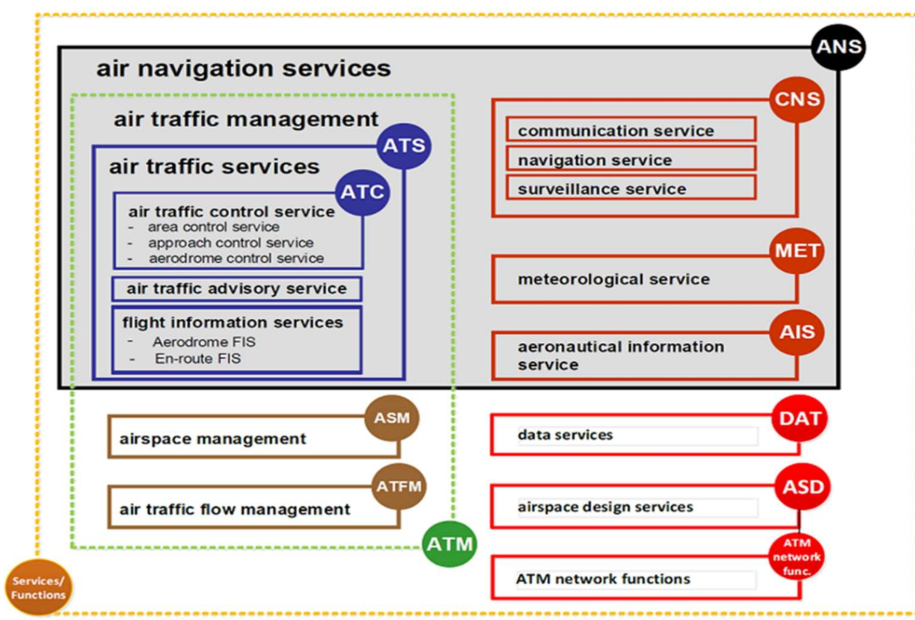

Fig. 4 - Map of the ATM/AS services provided today in the controlled airspace

Most air traffic is conducted in controlled airspace, i.e. where air traffic management and air navigation services are provided. Some basic air traffic services (FIS and Alerting) are also provided for uncontrolled airspace.
The SES regulations apply to general air traffic (GAT) and the EASA Basic Regulation to civil aviation. The following analysis of challenges relates **to civil aviation operations/ general air traffic** and excludes military or space flights which are addressed in a separate paragraph.

<u>Challenges</u>
These ATM/ANS services are currently not provided in the higher airspace, as there is no traffic demand to be managed in this airspace until now. In contrast to todays' airspace traffic, the HAO traffic in the future might not be that uniform.
Indeed, the air traffic management for en-route is designed for vehicles manoeuvring with constant speed at constant flight level. It is expected that HAO operations will also include movements on ballistic trajectories, as well as vehicles with very slow movement (HAPS). Thus the current ruleset and way of managing air traffic in upper airspace is not suitable for maintaining safety and efficiency in HAO and the future rules will depend on whether the vehicles/aircraft will be cooperative or not. In addition also, technical limitations in CNS limit the applicability of available concepts to HAO and require new approaches.

The HAO civil aviation operations can be categorised as follows:

- Transition from the ground to HA, through the currently controlled airspace
- Operations within the HA

The functions and services required to support the HAO should be analysed for each of these phases, keeping in mind the expectation to create an **innovative, collaborative and seamless system, based on high levels of digitalisation and automation**, and therefore potentially departing from existing solutions and concepts.
HAO is an opportunity to implement the recommendations of the SESAR JU 'Architecture study'[23], such as the airspace re-configuration or the de-fragmentation of European skies through virtualisation and the free flow of data among trusted users (ATM data as a service). The new concepts include also dynamic airspace management, 4D operating zones, trajectory -based operations, collaborative decision-making, strategic de-confliction, self-separation, fewer or single sector over the EU, etc.

Airspace classification
Some Member States have published Class C up to FL660 and Class G above FL660 and others have kept the higher airspace unclassified. However, this is not in line with regulation SERA.6001(b) which states that all airspace above FL 195 shall be classified as Class C airspace[24]. During EASA Standardisation Inspections, no findings were raised against this requirement (yet) since this airspace

[23] A proposal for the future architecture of the European airspace, SESAR Joint Undertaking , 2019

[24] Regulation 923/2012, as revised by regulation 2016/1185, addresses the issue of airspace classification above FL 195 (" The designation of the airspace classification shall be appropriate to the needs of the Member States, except that all airspace above FL 195 shall be classified as Class C airspace")

is not normally really used. The Member States concerned were informed about this inconsistency in the form of an observation. This SERA requirement should be respected unless it is the intent to change this rule in the near future, in view of the HAO developments and recommendations from the ECHO project.

Operations and separation

The CONOPs developed by the ECHO project indicates that during the transiting phase of HAO through the conventional traffic, separation will be ensured by ATC based on established separation criteria. In the Higher airspace, HAO will be carried out based on the agreed trajectory or 4D operating zone, acting as a dynamic airspace reservation.

Assuming that HAO will be made up of cooperative traffic and non-cooperative traffic, (i.e. traffic that can change their flight trajectory and those who cannot), dedicated HAO separation rules will be necessary in addition to Regulation (EU) 923/2012, the Standardised European Rules of the Air (SERA). These rules should reflect the different types of movement, speed and manoeuvring capability. Separation should be ensured also for vertical moving vehicles and any kind of 3D trajectory. The principle of vertical separation measured in barometric altitude might not be applicable in HAO due to very low air pressure which makes a reliable pressure altitude unavailable. Airborne collision avoidance, as regulated in Regulation (EU) 1332/2011, might not be feasible in HAO traffic for the same reasons. The capability of current airborne collision avoidance needs to be assessed and potentially amended for HAO usage.

Enabling services: CNS, MET, spectrum, space weather

Current available CNS services, certified in conformity with EU2017/373, will not necessarily be capable of handling HAO. As a minimum, the requirements for current CNS equipment should be extended to also meet the HAO needs. It might be more efficient to define the necessary CNS equipment for HAO independently from existing air traffic equipment, taking into account the specificity of HAO in terms of very high altitude, sometimes high speed, exposure to radiation and space weather effects. Depending on the air traffic management operations and responsibilities in HAO (which have to be defined first), suitable CNS technology should be selected. Interference and performance impacts to existing CNS systems would have to be studied and considered, including the allocation of exclusive radio frequencies if needed.

In this regard, the EU Space Surveillance and Tracking service, providing today space debris re-entry predictions could perhaps provide additional and more general support to civil aviation: it would have to be assessed whether its sensors and assets (radars, telescopes, etc.) could track not only re-entering debris, but also higher airspace operations.

Due to the high altitude, HAO will be more exposed to space weather effects. However, while today MET services provide space weather forecast for conventional aviation, they do not provide forecast for the layer of airspace above FL600[25]. It would have to be verified whether the capability to build these forecasts exists. A deeper analysis of this aspect will be needed.

[25] Regulation EU 549/2004, 'meteorological services' means those facilities and services that provide aircraft with meteorological forecasts, briefs and observations as well as any other meteorological information and data provided by States for aeronautical use'; and Commission Implementing Regulation (EU) 373/2017, Annex V.

Operational Roles and Responsibilities

In HAO, responsibilities might be different to the ones in traditional air traffic control, for instance in 4D operating zones. A self-separation responsibility of the vehicles might be more efficient and safer compared to a classic controller responsibility. Especially, the co-existence of manned and unmanned traffic in the same airspace will see a push towards new lines of responsibility – in conventional airspace as well as in HAO. With these new responsibilities also the ATCO licensing according to EU2015/340 might change, as well as the air navigation service provider (depending on the service to be provided) which could be, for instance a company as in U-space airspace or a Pan-European entity, managing the whole HAO over Europe in a seamless manner. It needs to be clarified how Regulation (EU) 1035/2011 might be applicable for such unconventional service provider managing HAO traffic. Following this, also the oversight responsibility according to Regulation (EU) 2017/373 for HAO service providers will have to be clarified.

Interoperability with lower airspace

Any flight to HAO will necessarily also manoeuvre/transit through the airspace below FL550 for take-off and landing. Thus the technical equipment and operational requirements must be in line with Regulation (EU) 2017/373. Some existing technical concepts (surveillance, communication, etc.) cannot be transferred due to technical limitations, the concepts currently in use for air operation cannot simply be extended to HAO[26]. Different technology is needed for the same purpose. This results in the need for equipping aircraft with suitable technology which then should also be compatible with classic ATC/CNS standards – or the other way around: conventional ATC/CNS providers also supporting transition to HAO must be compliant with HAO technology.

Military and space traffic

The SES regulations and the EASA BR do not apply to military[27] or space operations. However, these flights will transit through the currently controlled airspace and through the HAO and should therefore be taken into account.

The separation between military operations requiring segregation and civil aviation operations is today based on the concept of Flexible Use of Airspace (FUA). Commission Regulation (EC) 2150/2005 laying down common rules for the flexible Use of Airspace (FUA) aims at providing a temporary airspace segregation based on real-time usage within a specific time period for the exclusive use of some users. This concept should remain applicable for HAO military flights when transiting through the lower airspace and when cruising at higher altitude.

The Agency considers that the scope of this Regulation is not limited to military operations, since it can benefit military aircraft "*as well as any other parties requiring airspace*". This means that for instance the needs of space launchers/vehicles could be accommodated based on the same principles and procedures as for military aircraft, under the responsibility of Member States and with adequate information of the Network Manager for civil aviation planning purposes, particularly for military or space cross-border operations.

[26] For instance, ADS-B surveillance is not suitable for aircraft travelling faster than 1852 km/h -Source "Emerging Aviation Technologies – Preliminary analysis" Australian CAA August 202.

[27] Unless the military flight has opted for operation under civil rules

At least in the short term**,** the usage of FUA for the military and space flights transiting lower airspace and then the higher airspace would be a pragmatic approach. Should the number of such flights increase and consequently negatively impact civil aviation traffic, specific re-assessment might be needed in the mid to longer term, based on lessons learned from the initial operations.

Recommended actions

At least the following Regulations will need to be thoroughly analysed and possibly amended to allow HAO aircraft operations, in line with the agreed CONOPs:

- Commission Regulation (EU) 2015/340 of 20 February 2015 laying down technical requirements and administrative procedures relating to air traffic controllers' licences and certificates
- Commission Regulation (EU) 1332/2011 of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance
- Commission Implementing regulation (EU) 923/2012 of 26 September 2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation
- Commission Implementing Regulation (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, 2017/373 on CNS equipment and ATM operations
- Commission Implementing Regulation (EU) 2019/123 of 24 January 2019 lays down detailed rules for the implementation of ATM network functions
- Commission Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace

The following actions will also be required:

- The entire SES and EASA regulatory packages would need to be scanned and re-assessed. Additional regulation might also be needed, depending on HAO characteristics and operational requirements;
- Research and studies on the suitability and limits of the current CNS systems in relation to HAO flights would need to be assessed; Technical assessments for CNS capabilities in HAO use-cases are needed as baseline for further ATM concept creation in HAO;
- Research and studies on the prediction of space weather in the HA would be needed;
- Continuous improvement of the monitoring of the re-entry of space objects;
- The capability of SST sensors to provide surveillance services in HA would need to be assessed (i.e. between 20 and 80 km altitude).

4.5 Aerodromes/stratoports/spaceports

Field of application / principles

After an initial assessment, the EASA TF on HAO has proposed to distinguish between three categories of take-off/launch and landing/re-entry sites[28]: **aerodromes** for horizontal take-off of supersonic, hypersonic, MHTA and launch aircraft, **stratoports** for LTA HAPS, and **spaceports** for suborbital operations.

Aerodromes that are falling under the scope of Regulation (EU) 2018/1139 are defined in Article 2(e) of the Regulation and Regulation (EU) 139/2014 defines the condition for their certification and operation. They cover aerodromes which meet certain criteria, i.e., having an instrument runway which has a length of more than 800 m and serve commercial air transport. EASA/EU existing rules will apply when these aerodromes are used for horizontal take-off and landing HA operations and also in case of co-location, i.e., in case they are either stratoports or spaceports as well. The EU rules would have to be complemented with specific national requirements related to the HAO specificities and flight corridors. However, if the aerodrome does not fall under the EASA scope, the State concerned will have to develop national rules, unless a decision is taken to extend the scope of the EASA Basic Regulation to include notably spaceports and to develop common rules for them. The issue for ground handling services at HAO aerodromes/stratoports would have to be assessed.

Challenges

- For stratoports, it will have to be assessed if stratoports can be considered as aerodromes in the EASA regulatory context, or not. If they are, the regulation(s) may have to be amended. As an example, some vehicles used for HAO may use fuel which is different from the ones currently used for normal operations. A different type of fuel may require changes in rescue and firefighting strategies, means (extinguishing agents and equipment) and training of personnel. It may also require a change in the operational procedures of the aerodrome during launching operations. In addition, if the dimensions of the vehicles are larger than the largest dimension that the aerodrome is designed for, a specific safety assessment will be required.
- For spaceports it is not clear if the EASA Basic Regulation will apply:
  - Not all aerodromes fall under the scope of the Basic Regulation. Only those that are open to public use, serve CAT and have a paved instrument runway of 800 metres. For example, a military aerodrome, where some of the first launches might take place, is outside the scope of the EASA Basic Regulation and consequently, EASA has no mandate to develop any design characteristics or operational requirements for those aerodromes that are controlled by the military but used for commercial HAO.
  - If there would be a (horizontal take-off) spaceport co-located at an 'EASA aerodrome', the ECHO project recommends that the airport operator is also the spaceport operator, thus bearing the ultimate responsibility for all activities carried out on-site. In such a case, EASA could be tasked to develop the design characteristics for those spaceports in the future. In addition, spaceports could have a safety impact on the existing infrastructure of classical ADRs, e.g. for firefighting purposes.

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[28] See EASA TF Document 'Operations, Vehicles and Infrastructure Categorization (OVIC)', Part 7

- In case the spaceports do not fall under BR's competence, the Agency could nevertheless offer to provide guidance to Member States, like what is done for vertiports (UAS).

Recommended actions

→ Assess and possibly revise Regulation (EU) No 139/2014 if HA operations are taking place at aerodromes falling under the scope of the Basic Regulation, using the outcome of regulatory sandboxes tests already conducted by Member states

→ Or prepare a separate regulation for aerodromes when used exclusively for the vehicles conducting HAO (possibly creating new TO/launch and landing/re-entry sites categories).

→ Possibly develop non-binding guidance material for stratoports and spaceports not falling under EASA's scope

→ Assess the need to address ground handling services at HAO aerodromes/stratoports in the context of EASA rule-making task RMT0728 and/or under the future regulation.

4.6 Personnel licensing

Field of application / principles

The type of aircraft that will be used for such operations could have a significant impact on the crews' licences and certificates, including the medical ones, provided for in Regulations (EU) 1178/2011 and (EU) 965/2012.

4.6.1 FCL (initial training) and ORO.FC/CC (operator training)

Challenges

At this stage, the type of aircraft used for HAO represents a possible challenge that will impact the two above mentioned Regulations.

Recommended actions

The following considerations have been made to address the flight and cabin crew requirements:

→ The current pilot licence and cabin crew attestation frameworks should remain unchanged and applicable to HAO aircraft, although some stricter requirements or additional (specific) training requirements (e.g., atmospheric/tropospheric weather, performance, pilot experience) could become applicable, if not fully addressed in the Operational Suitability Data (OSD).

→ The current theoretical knowledge programme, developed for Commercial Air Transport (CAT) operations, does not ensure that the specific challenges related to high altitude operations are properly addressed. For this reason, an additional ad-hoc HAO training should be developed by the operator and approved by the competent authority.

→ The pilot type rating training and type specific data for cabin crew will be defined by the OSD during the certification process, with no, or very limited, impact on the current EU framework.

→ The Operator Conversion Course, the annual Recurrent Training and the combined CRM training, foreseen by the regulation, have to be redesigned to address the HAO normal and abnormal situations.

→ The qualification of Flight Simulation Training Devices (FSTD) used for the HAO type rating training could be heavily impacted by the type of aircraft used for HAO operation and its performances (G-force, supersonic, hypersonic, etc).

→ New training technology will be introduced to ensure that a proper training, corresponding to the technology evolution of HAO, is delivered. Regulation should be flexible enough to allow its use.

4.6.2 MED

Challenges

Currently applicable literature regarding suborbital flights and related stresses on human body states that the duration of these flights is expected to be between 1.5–2.5 h with one excursion of 3–4 min in microgravity. Duration and intensity of the exposure to stresses will define the pilot medical standards and the content of medical examination. The stresses of suborbital flight might include: acceleration (G-forces), barometric pressure changes, microgravity effects, ionizing radiation, noise, vibration, cabin air quality and spatial disorientation. Some of them are not considered as a significant factor for medical certification.

Commercial companies are building vehicles of different design, capabilities, and flight profiles, therefore the stresses will vary from one HAO vehicle to another. As a consequence, the recommendations for pilot medical standards and for the medical examination must be flexible, allowing for these differences.

Recommended actions

Taking this into account, the following recommendations might be provided with regards to Regulation (EU) 1178/2011:

→ Study stress levels for each category of HAO (at least through a literature review)

→ Revise currently applicable class 1 aero-medical requirements (including limitations) taking into account HAO related stresses and, if found necessary, adapt them for the medical certification of the suborbital space pilots.

→ Consider training needs and certification process for the aero-medical examiners with privilege to perform medical examinations of the suborbital space pilots.

→ Consider medical certificate validity period of the suborbital space pilots.

→ Revise the content of the medical examination for the class 1 medical certificate and, if necessary, propose changes/additions specific for HAO. Depending on the outcome, consider the need of a special medical testing equipment (amendments in the Part-ORA).

→ Consider administrative issues regarding medical certification of the suborbital space pilots from the perspective of the competent authority for the possible amendments of Part-ARA:

- Qualification of medical assessors;
- Certification and oversight of the involved aero-medical centres and aero-medical examiners.

→ EASA should liaise with the European Space Agency to gain knowledge on the medical standards and examinations applicable to suborbital and space operations.

→ For persons on board of the HAO aircraft, passengers or participants a study should be conducted to assess the potential medical requirements to be imposed on them.

4.7 Drones / UAS

Field of application / principles

Some of the HAO aircraft will fall under the definition of UAS, i.e. 'any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board'[29]. Some HAO UAS will be operating at very high altitude and will not be alone, i.e. they will share the airspace with manned aircraft. Depending on the operational risk of those UAS operations at high altitudes, they may be classified in the specific or certified HAO categories.

Challenges

Considering that HAO will include manned and unmanned aircraft, most likely those unmanned operations will be classified in the higher risk of the specific categories as it is expected that they share the same airspace. Therefore, the HAO UAS should be certified or at least being provided with a design verification review by EASA, as foreseen in Regulation (EU) 2019/947.

Operational authorisations for UAS operations in HA should follow a risk-based approach similar to what has been done for UAS in the specific category in Europe. However, care should be taken due to the fact that the airspace will be shared between manned and unmanned traffic and therefore for the purpose of safety continuum of the operations we should apply the same safety approach.

In terms of airspace management and considering the speed of some HA vehicles and that manned and unmanned traffic will share the same airspace, there will be a need to develop and demonstrate an advanced traffic management approach which should be cooperative and connected. A mid-air collision model should be developed considering such mixed traffic. This does not include the ATM procedures to transit and bring the vehicles to the higher airspace.

Annex 1 to the EASA Basic regulation , which excludes from its scope some aircraft (research, experimental, scientific, etc.) is limited to manned aircraft. This means that the UAS regulations are then applicable to flight testing. In order to support flight testing of complex applications; EASA is supporting the UAS industry and NAAs by providing some guidelines for flight testing. A similar approach could be used to develop guidance material for conducting flight testing in the area of HAO.

Recommended actions

The standard provisions on UAS will apply to the design and operations of the unmanned HAO. However, a specific air traffic management approach will have to be developed for the operations of UAS in the higher airspace since the U-Space will not be transposable to higher altitude.

→ Develop a mid-air collision model based on mixed traffic (manned/unmanned)

→ Develop a new performance-based air traffic management approach for HAO ensuring the safe integration of both manned and unmanned aircraft, consistent with U-space principles in the airspace transition phase to HA and drawing on some innovative concepts of U-Space (e.g. in-flight capability based on I-conspicuity[30]).

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[29] Paragraph 30 of Article 3 of Regulation (EU) 1139/2018 / Article 2(1) of Regulation (EU) 2019/947 and article 3(3) of Regulation (EU) 2019/945

[30] "in-flight capability" to transmit position and/or to receive, process and display information about other aircraft, airspace, obstacles or weather in real time with the objective to enhance pilots' situational awareness

4.8 Cybersecurity

Field of application / principles

Information security aspects of HAO shall be considered in order to identify and manage those information creating security risks with potential impact on aviation safety.

Challenges

The current regulatory framework already contains cybersecurity specifications for aviation products and approved organisations (e.g., CS-25.1319, CS-27.1319, CS-29.1319). The undertaken approach allowed to foster the development of 'secure by design' products by introducing objectives in the type certification, and set the basis to improve the cyber-resilience of the aviation system by requiring approved organisations to implement a structured process to manage information security risks in operations.

Recommended actions

→ Re-evaluate the current scope of the information security regulations, in order to assess the need to extend the applicability of the above-mentioned requirements to new aviation products and approved organisations (e.g. spaceports). The purpose of the re-evaluation would be to assess if certain activities and the relevant organisations (under EASA approval) may pose information security risks with the potential to generate events that can have direct consequences on the safety of flight. In doing this, several inputs such as the type of operations and the interfaced organisations should be considered.

4.9 Environment

Field of application / principles

Assuming an HAO vehicle qualifies as an aircraft (ref. challenges identified in 2.4.1), Article 9 of Regulation (EU) 2018/1139 requires aircraft to be compliant to noise and emissions requirements contained in the respective environmental protection requirements of Volume I, II, III of Annex 16 to the Chicago Convention. However, for aircraft types (e.g., HAO vehicles determined to be an aircraft) for which the Chicago Convention does not contain environmental protection provision, the essential requirements for environmental compatibility set out in Annex III of the Basic Regulation shall be applied. Article 19 of the Basic Regulation says that in such case the environmental protection requirements shall be adopted in a delegated act. The delegated act shall remain applicable until the Chicago Convention has adopted the environmental protection requirements applicable to the aircraft type previously not yet covered.

Challenges

Notwithstanding the fact the novel HAO concept may include environmental friendly technologies (e.g. use of green hydrogen, battery/hybrid propulsion) some specific challenges need to be tackled such as:

- **Noise**: supersonic and hypersonic flights, as well as suborbital vehicles and re-entry of vehicles may trigger sonic booms leading to a significant noise impact for affected population. Moreover, as requested by its Member States, EASA has issued an NPA to Regulation (EU) No 923/2012 (Standardized European Rules of the Air) proposing a speed-restriction to supersonic aircraft to avoid an overland sonic boom. Other noise impacts specific to novel HAO vehicles (local noise around airports) shall also be investigated. Societal expectations may lead to a non-acceptance of the HAO operations on the basis of potential significant noise impacts (e.g. higher than current applicable ICAO based noise limitations). Due to a lack of comparable aircraft types or unavailability of test data/test aircraft, a specific challenge relates to determining the appropriate noise metrics and noise certification limitations applicable to the HAO vehicle.

- **Climate impact**: some HAO vehicles may lead to higher levels of emissions of greenhouse gases compared to conventional aircraft types. The impact of such higher levels of emissions shall be assessed and appropriate limits at aircraft level shall be determined. Similar to noise requirements, the lack of available test data due to the novelty of the concept may pose additional challenges to set the appropriate emission certification limits. A particular challenge related to the non-CO2 effects on climate change may have to be addressed carefully as those other greenhouse gasses emitted at higher altitudes may have a more damaging effect than is currently the case for flights within the troposphere.
- **Local air quality**: environmental impact assessments should also include local air quality impact around airports/launch pads from HAO operations.
- **Lifecycle and disposal**: an assessment of the lifecycle/disposal/re-usability of the aircraft/vehicles would be useful.

Recommended actions

→ Identify research areas needed to have a better scientific understanding of the impact of HAO vehicles on the environment (e.g. study on the local noise impact and noise certification levels of high-speed HAO aircraft, study on non-CO2 effects, etc.)

→ Initiate environmental impact assessments , identity potential environmental metrics and limits which can be used in new environmental protection requirements necessary to certify HAO vehicles

→ Investigate the need for policy actions at EU level to mitigate the adverse effects on the environment from HAO vehicle operations, such a delegated act defining environmental protection requirements, or an update to the ETS Directive, or mandatory use or incentives for use of SAF, etc.

→ Consider life-cycle assessments of projects, including the production, operational life and disposal (for the system and energy/fuel used).

4.10 - Occurrence reporting

Field of application /principles

Art. 72 of the EASA Basic Regulation and Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation, impose the mandatory reporting of occurrences related to aircraft, ATM/ANS or aerodromes.

Challenges

The regulations and the reporting categories in the European Central Repository do not include specific reporting for incidents/accidents at high altitude or for incidents in the controlled airspace involving space-related hazards, such as near collisions with space craft (launch or re-entry phase) or space debris. As a consequence, very few lessons learned can be derived from existing reported occurrences.

An initial search in ECCAIRS has revealed 5 reported occurrences since 2017 for flights above FL 500, 3 of them concerning military aircraft (airspace infringements), 1 concerning a civil drone (no flight plan) and 1 concerning a scientific supersonic aircraft (ATC overload). A number of results concern balloons, but with no indication of their altitude, since this database entry is not mandatory. Finally, some incidents related to the loss of communications due to solar flares were reported in oceanic areas, so likely at rather high altitude.

Recommended Actions

→ Enlarge the scope of Regulation (EU) 376/2014 (occurrence reporting) to HAO under the scope of EU regulations

→ Raise awareness on HAO through safety promotion and mandate the reporting of the altitude of the flight in the ECCAIRs database

→ Once awareness is sufficient, create a dedicated category in the database for incidents related to HAO

4.11 - Civil-military coordination

Field of application / principles

Military aircraft are in principle excluded from the scope of application of EU civil aviation regulations. Although no specific concept of operations has yet been developed, HA space will probably be used for military operations at least to ensure “Air policing” activities of this airspace but also for surveillance or communication activities (some preliminary projects on which EASA is already involved).

Moreover, the military already operate in space with dedicated satellites. The military dimension in the HAO depends on the successful approach to the connection between High Airspace Traffic Management System and the Space Management System. Therefore, proper civil-military coordination, communication and collaboration, are essential.

Challenges

The challenge consists in applying in the higher airspace the same principles that exist for the ‘lower’ airspace, i.e. the future HAO operations should not hinder military operations and ensure their freedom of access. To this effect, it will be necessary to ensure interoperability of systems and processes, effective exchange and sharing of data and information, prioritization of military aviation for trainings and for missions, protecting security and defence priorities, granting timely availability of optimal routes, protection of confidential and critical mission information, etc.

Another challenge is to take into account military operations to the maximum extent possible, when developing the requirements, not only for traffic management, but also for new air vehicles and safety management environments and systems to support possible future dual use/operations.

And finally, developing a strengthened cooperation/coordination between civil/military Air Traffic Management (ATM) and Space Traffic Management, will also be very challenging.

Necessary actions (by EASA or other actors)

- Update, when existing, working arrangements between the competent civil and the military authorities to include HAO, or conclude such arrangements when they do not pre-exist.

- Coordinate, where necessary with the PESCO[31] and EDF[32] projects, where dual technologies developments may take place, which could impact HAO;
- Identify, where necessary, coordination activities to develop with Military Space Traffic Management organisations;
- Once the vehicles and operational concepts are more mature, launch a study on how to ensure efficient civ-mil collaboration in the HA;
- Collaborate with military representatives as soon as possible when developing new safety requirements for new Higher Space operating systems.

Conclusion No 8

Some HAO aircraft and their operations will in principle be subject to the EASA Basic Regulations and the Single European Sky. However most of the current implementing rules would have to be adapted and/or completed.

The EASA Basic Regulation allows for derogations from the application of existing rules in certain cases (e.g. Annex 1 for manned HAO aircraft designed for research/scientific/experimental purposes, exemptions under Art. 71 of the BR, etc.). The first HAO demonstrators could therefore take place under the responsibility of the Member States concerned, applying the regulatory/innovation sandbox concept.

5 Key objectives of EASA in this field

The key objectives of EASA in this field are to ensure a high uniform level of civil aviation safety, environmental protection and security in all the EU airspace. This includes ensuring that HA operations are safe, secure and sustainable when flying in the higher airspace as well when transiting through the currently 'lower controlled airspace' and interfacing with current conventional traffic, without negatively affecting the safety, capacity, security and environment performances of the existing aviation system. It involves accommodating all airspace users' needs, whether they are civil aviation, military, or space operations. EASA's objective is also to encourage research, innovation and EU industrial developments, through regulation

The objective of the EU/EASA should be to ensure that **the safety objectives are set in such a way as to ensure a safety continuum and be consistent with those of commercial transport aircraft and operations**. The future regulatory framework for HAO should be safe, proportionate, risk-based, bearing in mind that the Task Force was considering that the specific nature of HAO may require using an operation-centric and risk-based approach as an alternative to the traditional full certification.

For HAO vehicle systems with occupants on-board, and comparable to General Aviation complex aircraft (e.g. in size, capacity, technologies), the TF proposed an overall safety objective (due to any cause, technical and operational) in the range of 1E-5 and 1E-4 (to be confirmed by further studies

[31] Permanent Structured Cooperation Projects under the EU security and defence policy

[32] European Defence Fund

and safety assessments) catastrophic event per mission[33]. As a consequence, the following safety targets were proposed for the HAO vehicle system's design certification:

(1) For each vehicle's system and (possibly) structures: a safety target of 1E-7 catastrophic failures per mission, and
(2) For the rocket motor system and related installation: an adequate safety target such as, in combination with the system reliability referred to in point (1), complemented with other mitigating means (ELOS), allows to achieve the overall safety objective of 1E-4.

However, these figures may need to be enhanced to ensure coherence with the safety targets applied for commercial transport aircraft and operations, manned and unmanned, i.e. 1E-6 to 1E-9, taking due account of the specific risks of HAO. In this regard, the SORA methodology could inspire the HAO safety approach.

Conclusion No 9 **Proposed safety objectives and safety targets for HAO** The safety objectives should ensure a continuum with the objectives applied for commercial air transport aircraft and operations, taking due account of the actual risk levels of HAO.

In terms of environmental impact, EASA should strive to ensure that HA aircraft operations comply with existing international and EU norms and standards, possibly complemented with ad hoc requirements and recommendations linked to HAO specificities as well as to the specific European context, to ensure that these operations do not have any negative environmental impact on the ground or in the higher airspace.

Finally, regarding the use of the airspace, the expectation is to create an **innovative, collaborative and seamless higher airspace aviation system, based on high levels of digitalisation and automation**, and therefore potentially departing from existing solutions and concepts, and exploring for instance the concepts of dynamic airspace management, 4D operating zones or corridors, trajectory-based operations, collaborative decision-making, decentralised/distributed traffic management (like in U-Space), self-detection and separation, operator-managed deconfliction, space connectivity, etc.

6 Available high level policy options

6.1 Option 0 – Do nothing

This option consists of taking no action at EU level. As a consequence, future HAO vehicles and related operations would have to be authorised by each of the Member State(s) in which they take place, for instance as local demonstration /scientific or military flights, using Permit-to-Fly or possibly applying the concept of 'regulatory sandboxes' that remain to be clarified, in particular taking into account the specificities of each one of the very diverse HAO categories considered.

[33] This figure will have to be validated, e.g. by applying a regulatory sandbox approach).

This option could be justified by the slow development of HAO vehicles. It is unlikely that massive commercial HAO vehicles production and operations will take place in the EU airspace in the next 2 to 3 years.

This option entails however a risk of fragmentation of the regulatory framework and difficulty in achieving a level-playing field and internal market for HAO in the future, detrimental to industrial developments. It would be a missed opportunity to test new aviation concepts in a virgin environment.

6.2 Option 1 – EU intervention on a case-by-case basis and preparatory work

This option consists of EASA supporting partially the development of HAO falling under the scope of EU competence on a case-by-case basis and through progressive preparatory actions under the current regulatory framework, aimed at better understanding the needs and constraints of HAO. These actions include studies and research actions, production of guidance material, collection of data, information and literature, creation of a network of stakeholders, etc. (see Annex 3).

6.3 Option 2 – Preparation of the full regulatory framework for HAO

This option consists of implementing Option 1 actions, as well as in parallel starting to draft an EU regulatory framework to enable HAO, for the elements falling under the EU/EASA competence. The timeline for the development of commercial HAO in Europe (probably not before 3 years) offers a rare opportunity to anticipate this development and create a framework in advance.

This objective could be achieved in two ways, after a thorough regulatory gap analysis and impact assessment and provided that the characteristics and the performances of the vehicles are known, while considering the developments at ICAO level (HAO SARPS), the availability of research data, test data, environmental impact assessments and potential metrics and policies to measure and mitigate the environmental impact of HAO vehicles.

Option 2A

This option would amend all existing relevant implementing or delegated regulations to ensure that the HAO dimension is correctly addressed. As identified in this Roadmap (§2.6), most of the existing regulations apply to HAO vehicles and operations of **the aircraft category** but would need to be adapted to take into account their specific characteristics to allow regular civil aviation operations (see Annex 4). Additional regulations may be necessary.

Option 2B

This option would consider the preparation and adoption of an ad hoc and separate regulatory package on HAO, as was conducted for drones. This would be justified by the novelty of HAO and the fact that several aspects would be new.

Conclusion on the high level options

Option 2 aimed at creating a fully-fledged regulatory framework for HAO civil aviation safety and sustainability would be ideal, however, there are too many uncertainties relating to HAO industrial/commercial developments, future vehicle characteristics and deployment in the EU, to regulate immediately. In the meantime, it is considered that **Option 1** would adequately respond to the initial needs of the sector for the next 2 to 3 years. Depending on the results of the additional studies launched under Option 1, a second phase could start in mid-2025 with Option 2.

Conclusion No 10

It is recommended to implement Option 1 as of 2023 and launch the proposed studies and preparatory actions in order to know better the subject, with a view to initiate regulatory developments in a second phase (i.e. as of mid-2025).

7 Proposed action plan

7.1 Actions

7.1.1 Option 1

Option 1 includes **six categories of preparatory actions**:

1. **Support to industrial developments**: in order not to block industrial developments during the preparatory phase of Option 1, it is proposed to accompany and support industrial projects interested in a possible EASA certification, through pre-application contracts and/or the development of special certification conditions, in case they relate to new products for which no certifications specifications exist today. In order to facilitate initial contacts, EASA will create a webpage with relevant material, FAQs and contact points.

No	ACTION	DELIVERABLE	OWNER	TIMELINE	
				Starting date	Ending date
SUPPORT TO INDUSTRY DEVELOPMENTS					
1	Pre-application contracts	2 pre-application contract reports per year	EASA	On-demand (as of mid-2023)	2 years after pre-application
2	Development of special conditions for the certification/validation/approval of new HAO aircraft/engine designs	2 sets of Special conditions	EASA	On-demand (as of mid-2023)	2 years after application
3	Publish a HAO webpage on EASA's website with FAQs, contact point, useful material and links	EASA webpage	EASA	Mar-23	Apr-23

2. **Building the regulator's know-how and raise awareness**: it is proposed to develop guidance material on the 'regulatory sandbox' concept supporting Member States and the industry to conduct the first tests and demonstrations in the EU, exempting these tests from the application of relevant EU regulations. EASA intends to associate itself or support closely these tests in order to learn and gain knowledge to better prepare the future regulations. In parallel, the Agency will progressively build in-house competence on all aviation domains related to HAO, through training, creation of a library on HAO (total aviation system), improved occurrence reporting and the creation/maintenance of a network of external stakeholders.

No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date
BUILD REGULATOR's KNOW-HOW AND RAISE AWARENESS					
4	**Support to HAO tests and demonstrations through guidance on 'regulatory sandboxes'**	4.A GM on regulatory sandbox	EASA	Mid 2023	End 2023
		4.B Participation/support to tests	EASA	As of mid-2023	Continuous
5	**Awareness raising on HAO in the Agency to ensure that implementing or delegated acts do not prevent HAO when they are drafted or amended;**	Internal awareness events (e.g. lunch time webinars)	EASA	As of 2023	Continuous
6	**Progressive competence building and training for EASA and Member States' staff**	Leaflet on HAO A dedicated EASA webpage with a contact point Library on HAO accessible to external stakeholders EASA contact point for information	EASA	As of 2023	Continuous
7	**Creation/maintenance of a network of EU HAO stakeholders**	List of EU governmental HAO stakeholders List of EU industry/non-governmental HAO stakeholders 1 meeting + meeting report per year	EASA/COM	By mid 2023	Continuous
8	**Improve occurrence reporting on HAO**	New/specific entry in ECCAIRS	EASA	Mid 2023	Mid 2024
9	**Literature review on HAO and related new technologies (from total aviation system perspective)**	Literature review and analysis	EASA	Mid-2023	Mid 2024

3. **Conduct of scientific studies**: the conditions and environment in the higher airspace are still largely unknown and there is a lack of scientific data to drive regulatory choices. For this reason, it will be essential to rapidly launch studies to collect critical data related for instance to: weather phenomena and their possible impact in the higher airspace, space weather, availability and performance of current CNS capabilities and identification of possible alternative means, impact of HAO on human health and medical requirements for crew and passengers, availability of spectrum, etc. Synergies with ongoing EU research programmes could be explored, as long as EASA is closely associated with the studies technical specifications, progress and results so that they can ultimately be useful and feed the regulatory impact assessments.

No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date
CONDUCT SCIENTIFIC STUDIES					
10	**Launch of specific scientific studies to support future regulatory work, e.g.** - Regular updates of demand analysis - Study on CNS needs and capacities in Higher Airspace (incl. suitability of existing CNS capabilities and potential alternatiuve means) - Study on the Assessment of the capability of SST sensors to provide surveillance services in HA - Study on the impact of HAO on human health (pilots, crew), including stress levels + liaison with the ESA to gain knowledge of medical standards and examinations for suborbital and space operations - Study on HAO frequency/spectrum needs - Study on the availability of MET and space weather forecast for the higher airspace - Study on the medical standards/requeirements criteria to be defined to allow HAO passengers to fly - Study on societal acceptance of HAO - Study on the efficient civil-military collaboration in the HA	Study reports	COM/EASA/SESAR/CLEAN AVIATION/INEA/EDA	Early 2024	End 2025

4. **Conduct of legal and regulatory assessments**: a detailed legal/technical analysis of the 'hybrid' HAO operations and vehicles will be needed to determine if some of them should be governed by air law. Once the future HAO vehicles/aircraft, their operations and the HAO

environment will be better known, detailed assessments of their possible safety, environmental and cyber-security impacts will have to be made. A more systematic and detailed gap analysis should then be conducted to ensure an exhaustive overview of the missing elements in the existing implementing regulations, as well as in the EASA Basic regulation and the SES Basic Regulations.

No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date
CONDUCT LEGAL AND REGULATORY ASSESSMENTS					
11	**Detailed legal analysis of 'hybrid vehicles' and their applicable legal regime**				
12	**Analysis of Basic acts (BR + SES) to assess their scope and applicability to HAO and prepare future amendments if and when needed.**	Assessment report and draft amendments	EASA/COM	As of 2024	2026
13	**Detailed regulatory gap analysis and impact assessment on safety /sustainability regulations, incl.** -Assessment of the safety risks/objectives of envisaged HAO operations, incl. the possible applicability of the SORA methodology - Assessment of the security and cyber-security risks of HAO - Assessment of the environmental and noise impact of HAO (e.g. (green houses gas emissions, impact on the ozone layer, etc.)	Gap analysis report	EASA	As of mid 2024	Mid- 2025
14	**Gap analysis on other EU regulations on civil aviation (internal market)**	Gap analysis report	COM	As of mid-2024	End 2025

5. **Link/synergies with other EU policies**: it is proposed to take benefit of the other EU policies to facilitate the development of European HAO. The EU Space Programme could support through the provision of space-based CNS services as well as through the EUSST re-entry service and space weather services. Coherence and proper interface will have to be ensured between space traffic and aviation traffic management. The development of HA operations near or above the sea will have to be consistent with the EU maritime safety policy. Finally, a very close coordination will have to take place with the security, defence, and military authorities, given the strategic interest and sovereignty component of the higher airspace.

No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date
LINK/SYNERGIES WITH OTHER EU POLICIES					
15	**Liaise with DG DEFIS and EUSPA**	Continuous coordination and improvement	EASA/COM	As of mid-2023	Continuous
16	**Improve the EUSST re-entry service for its use by aviation**	Continuous coordination and improvement	EASA/COM	As of mid-2023	Continuous
17	**Ensure coherence of regulations STM/ATM**	2 meeting reports/year	EASA/COM	As of mid-2023	Continuous
18	**Liaise with EMSA**	Various meetings + insertion in policy papers	COM/EASA	As of mid-2023	Continuous
19	**Liaise/cooperate with military authorities: EDA, NATO**				
20	**General policy and strategy**	2 meetings/year	COM/EASA	As of mid-2023	Continuous

6. **Regional and global interoperability**: given the characteristics of the HA operations, most of which will be cross-border, creating a harmonised level-playing field in the EU and with the neighbouring European States will be essential. On this basis, coordination and cooperation should be extended to third States to achieve as much as possible global interoperability. The EU should monitor and contribute to the rapid implementation of ICAO Resolution A41-9.

No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date
	ENSURE REGIONAL AND GLOBAL INTEROPERABILITY				
21	**Promote a European Regional approach** Liaise with ICAO RO Paris and non-EU European States	2 meetings per year	EASA/COM	As of 2023	Continuous
22	**Contributing to HAO interoperability at global level (ICAO) -**Monitor follow-up of Resolution A41-9	Meetings and reporting to the MAB	EASA/COM	As of 2023	Continuous
23	**Coordinate with UNOOSA**	Organise a meeting	EASA/COM	Mid 2023	Mid 2023

7.1.2 Option 2

Option 2.A involves the prior execution of the actions in Option 1. Option 2 actions depend greatly on the results of the studies and assessments conducted under Option 1. At least the following actions **may** be required:

- Amendments to existing regulations or drafting of new ones
- Development of training material
- Development of guidance material (for domains not under EASA's regulatory competence)
- Update of bilateral and international agreements for recognition of certification and licences

OPTION II						
No	ACTION	DELIVERABLE	OWNER	TIMELINE Starting date	Ending date	Dependency
21	Possibly update at least the following regulations: Regulations (EU) 2019/947 and Regulation (EU) 2019/945 on UAS Regulation (EU) 748/2012 on initial airworthiness Regulation 1321/2014 on continuing airworthiness Existing Certification Specifications (e.g. CS 25 and CS 31) Regulation (EU) 2015/340 on air traffic controllers' licences and certificates Regulation (EU) No 1332/2011 on common airspace usage requirements and airborne collision avoidance Regulation (EU) No 923/2012 on common rules of the air Commission Implementing Regulation (EU) 2017/373 on common requirements for ANS/ATSPs and other air traffic management network functions Commission Implementing Regulation (EU) 2019/123 on the implementation of ATM network functions Commission Regulation (EC) No 2150/2005 on the flexible use of airspace Regulation (EU) No 139/2014 on aerodromes requirements Regulations (EU) 1178/2011 and (EU) 965/2012) on pilot licence and cabin crew attestation frameworks Regulations on information security (to possibly extend the applicability to new HAO aviation products and approved organisations) Future regulation on ground handling services (RMT0728)	NPAs	EASA	Mid-2025	Mid 2027	After results of Actions 11 to 14
22	Possibly develop non-binding guidance for stratoports and spaceports not falling under EASA's scope	Guidance material	EASA	Mid 2025	Mid-2026	After results of initial studies under Action 9
23	Develop HAO personnel related training	Training material	EASA	2027	2027	After Action 21
24	Assess and update BASA agreements and TIPs if needed	Updated agrements	COM/EASA	2027	2027	After Action 21

7.2 Timeline

High level **Option 1** covers the period 2023- 2025/26. Most actions could start immediately, such as the complementary studies, training, gap analysis and impact assessment, etc. The preparation of Special Conditions (Action 1) would start upon demand. All actions should be finalised by 2026 to allow for possible follow-up and proposals in the next Multi-Annual Financial Framework.
During this period, Member States will be able to authorise experimental operations based on the regulatory sandbox concept.

High level **Option 2** would cover the period 2023 – 2030. The options start as of 2023, as it includes all actions of Option 1, with the possible exception of the development of special conditions (Action 2), depending on the type of aircraft to be certified. Option 2 involves also preparing or updating regulations, which could start as soon as the gap analysis and impact assessments are performed, i.e. as of mid-2025.

7.3 Resources considerations

The **internal** manpower resources required for **Option 1** are estimated at 6680 hours, i.e. around 830 man/days in total for the period 2023-2026 included. A budget of 3,2M€ is foreseen for **external** research studies and safety assessments, possibly using existing EU budget, such as SESAR, Clean Aviation, CEF, etc.
More detail is provided in Annex 3.

8 – ANNEXES

Annex 1	List of National legislations/regulations of the TF members
Annex 2	Preliminary definitions
Annex 3	Action list with budget impact
Annex 4	Gantt Chart

ANNEX 1

National legislations related to HAO

(as communicated by the States members of the Task Force)

FRANCE

- Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (https://www.legifrance.gouv.fr/loda/id/JORFTEXT000018931380/)

ITALY

- Regulation on the construction and use of spaceport (Spaceport Regulation), Issued in October 2020 (https://www.enac.gov.it/la-normativa/normativa-enac/regolamenti/regolamenti-ad-hoc/regolamento-per-la-costruzione-lesercizio-degli-spazioporti)
- Regulation for Suborbital and Access to Space Operations (SASO Regulation), under development, which will cover suborbital flights, aero-launched operations and re-entry from orbit operations *(under preparation)*
- Regulation for the Access and Use of the Higher Airspace (HATM/HANS Regulation) (*under preparation*)

FINLAND

- Finnish Act on Space Activities (63/2018; translation can be found on: https://tem.fi/en/spacelaw) applies to space activities which by definition means launching a space object into outer space, operation and other control of the space object in outer space, as well as measures to return the space object and its return to the earth (Sec. 4). There is no definition for "outer space" in the Act.
  According to the Act on Space Activities, a space object flying in the airspace of Finland is subject to applicable provisions on civil aviation (Sec. 1). In regard to safe conduct of space activities (Sec. 9) the Act states, that provisions on activities that endanger flight safety are laid down in section 159 of the Aviation Act (864/2014).

- Section 159 in Aviation Act (Activities hazardous to flight safety): Any activity that poses a hazard to air traffic or impedes the smooth flow of air traffic is prohibited. The air traffic service provider shall be notified in advance of any activity that may pose a hazard to air traffic or affect the traffic flow, so that the air traffic service provider can assess whether the planned activity can be performed without compromising flight safety or impeding the smooth flow of traffic. Where the planned activity cannot, by the means available to the air traffic service provider, be safely and smoothly adapted to other aviation operations, the Finnish Transport Safety Agency may prohibit or restrict the activity or impose conditions on it.

NORWAY

- Norway has a space act from 1969 and the orbital launches fall within the scope of this act. Act on Launching Objects from Norwegian Territory in Outer Space" Act n. 38 of 13 June 1969 UNOOSA website: https://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/norway/act_38_1969E.html)
- As of 1 January 2023, CAA Norway is appointed as the new space authority. This means the CAA will be responsible for oversight for both the aviation and space domain (see https://www.regjeringen.no/en/dokumenter/norwegian-airspace-strategy/id2864267/?ch=5)

SWEDEN

- Lag (1982:963) om rymdverksamhet Svensk författningssamling 1982:1982:963 t.o.m. SFS 2021:1025 - Riksdagen (Law on Space activities)
- Förordning (1982:1069) om rymdverksamhet Svensk författningssamling 1982:1982:1069 t.o.m. SFS 1994:114 - Riksdagen (Government regulation on Space activities)
- Förordning (2007:1115) med instruktion för Rymdstyrelsen Svensk författningssamling 2007:2007:1115 t.o.m. SFS 2021:40 - Riksdagen (Government regulation with instruction for the Swedish Space Agency

SWITZERLAND

- Federal law on aviation of 21 December 1948 (as amended on 1 Mai 2022), notably its articles 1 and 2 on the use of airspace by aircraft or ballistic vehicles.
- Ordonnance on aviation of 14 November 1973, notably Art. 23, which states that ballistic vehicles can be used and launched only with authorisation by the Federal office of civil aviation(FOCA), who defines the admission and exploitation conditions.

NB – The US and the UK have already adopted specific legislation addressing at least partly HAO:

- UK Space industry Act of 2018 https://www.legislation.gov.uk/ukpga/2018/5/contents/enacted/data.htm

- US regulation on commercial space, CFR Title 14, Chapter III (Commercial Space Transportation, Federal Aviation Administration, Department of Transportation) Parts 4XX includes some HAO. In particular Part 420 deals with launching sites and the new Part 450 deals with launching and re-entry licensing, including suborbital flight; https://www.ecfr.gov/current/title-14/chapter-I

ANNEX 2
PRELIMINARY DEFINITIONS

*Some definitions already exist in the ICAO or EU framework and are marked with *.*
An extensive list of other definitions/descriptions were developed by the EASA HAO TF and the ECHO Project, only some of them are reproduced hereafter.

***Aerodrome**
Means a defined area, on land or on water, on a fixed offshore or floating structure, including any buildings, installations and equipment thereon, intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft[34].

***Aeroplane**
A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight[35].

***Aircraft**
Means any machine that can derive support in the atmosphere from the reactions of the air other than reactions of the air against the earth's surface[36].

Air-launched flight

Flight of a system whose first stage is a carrier aircraft able to carry and release a rocket-propelled vehicle, intended to perform an orbital or suborbital operation.

***Airship**
Airship is a power-driven lighter-than-air aircraft[37].

***Airspace**
The (Single European Sky) airspace means the airspace above the territory to which the EU Treaties apply, as well as any other airspace where Member States apply Regulation (EC) No 551/2004, in accordance with Art.1(3) of that Regulation.[38]

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[34] Idem

[35] ICAO Annex 2 - Definitions

[36] Regulation (EU) 2018/1139 of the European parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency

[37] EASA Special conditipns for Gas Airships – 14.03.2021

[38] Alternative proposed definition: The space extending upwards from the surface of the Earth to the outer space and falling under the scope of the Chicago Convention / the EU Single European Sky and EASA Basic Regulations.

***(Aircraft) Flight Crew member**
A licensed crew member charged with duties essential to the operation of an aircraft during a flight duty period.[39]

***Controlled airspace**
Controlled airspace. An airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification. (*Note.— Controlled airspace is a generic term which covers ATS airspace Classes A, B, C, D and E as described in Annex 11, 2.6*)[40].

Heavier Than Air (HTA) HAPS

Heavier-than-the-air aircraft[41] intended to operate in the HA / stratosphere.

Higher airspace
The volume of the airspace *typically* above altitudes where the majority of air services[42] are provided today (i.e. around FL 550) and where Higher Airspace Operations (HAO) are carried out.

Higher airspace operations

Definition proposed by the Task Force
Air transport operations carried out by various types of aircraft or air transport vehicle systems within the Higher Airspace, including:

- Supersonic flights;
- Hypersonic flights;
- A-to-A suborbital flights and A-to-B suborbital flights (including sounding rockets and aero launching operations into a suborbital trajectory)
- HAPS, stratospheric weather/scientific balloons, and other subsonic UAS, HALE operations.

In addition, higher airspace operations may include space vehicle or systems transiting through the higher airspace and interfacing with the 'lower' airspace operations, which need to be taken into account for safety purposes:

- orbital operations transiting through the airspace for access to space (including aero-launching operations into orbit)
- and re-entry operations from space.

Definition proposed by the Agency
Air transport operations carried out by various types of aircraft or air transport vehicle systems in the volume of the airspace above altitudes where the majority of air services[43] are provided today.

[39] EASA SERA Regulation
[40] ICAO Anenx 2 - Definitions
[41] Heavier-than-air aircraft is any aircraft deriving its lift in flight chiefly from aerodynamic forces (Ref. ICAO Annex 7)
[42] Including ATC
[43] Including ATC

Higher Airspace Traffic Management (HATM)
The provision of functions and services to ensure safe and efficient operations in the higher airspace.

Higher airspace vehicle
Any object or system intended to fly or transit through the higher airspace. Higher Airspace vehicles include aircraft.

High Altitude Platform Systems (HAPS)[44]

Manned or unmanned aircraft intended to be operated in the higher airspace, also designated as "High Altitude Pseudo Satellites". Slow aircraft not exceeding the maximum buoyancy altitude that can be lighter-than-air (**LTA**, like balloons, airships) or heavier-than-air (**HTA**, like motorized gliders).

Hybrid Operations
HAO which may fall in principle under air law, space law or *ad hoc* law, according to each concerned State. As they are carried out by using vehicle systems combining different components which may have aircraft characteristics and could also be considered space object according to the Space Liability Convention.

Lighter Than Air (LTA) HAPS
Airship, motorized airship, or balloons intended to operate in the HA/ stratosphere, able to ascend by means of the buoyancy of a lifting gas that has a lower density than surrounding atmospheric gases.

Near-space
Space between the current upper limit of controlled airspace (i.e. around FL 550) and the lower limit of outer space. It also corresponds to the definition of higher airspace. (tbc).

Orbital Operation
An operation intended to place a vehicle system, or any portion thereof, or any payload into an orbit able to circle the Earth (elliptical or circular orbit) or to escape from Earth (hyperbolic orbit), or a re-entry flight. It includes aero-launching operations into orbit and re-entry flights.

[44] ITU definition: High Altitude Platform System (HAPS) is defined in No. 1.66A of the ITU Radio Regulations as a station located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth. ESA description: High-Altitude Pseudo-Satellite (HAPS) — an uncrewed airship, plane or balloon watching over Earth from the stratosphere. Operating like satellites but from closer to Earth, […]. Stratosphere/tropopause: We need to be careful here when using the term stratosphere: the lower boundary of the stratosphere is the 'tropopause'. The tropopause altitude varies from around 17km above the equator down to around 6km above the poles. Airliners flying polar routes often cruise at 11-13km altitudes, about two times higher than the tropopause at polar latitudes.

***Passenger**
Any person excluding on-duty flight and cabin crew members who makes a journey by air on board of an aircraft. Infants in arms are included.[45]

Reusable vehicle

A vehicle system that is fully or partly reusable for more than one flight or mission.[46]

* **Space debris**
Means any space object including spacecraft or fragments and elements thereof in Earth's orbit or re-entering Earth's atmosphere, that are non-functional or no longer serve any specific purpose, including parts of rockets or artificial satellites, or inactive artificial satellites[47];

Spaceport
A site on the Earth's surface whose infrastructure, facilities and equipment, as well as its technical requirements, specifically dedicated to launch/take-off, re-entry/landing, or ground/flight operation of a suborbital or orbital vehicle system. The site is structured to allow all the necessary operations to execute a flight, including related systems maintenance and preparation to flight. With respect to the purpose of operations, a spaceport may be classified as:

(a) suborbital spaceport,
(b) orbital spaceport, or
(c) multipurpose spaceport

With respect to the take-off/launching or landing/re-entry mode of the vehicle system or parts thereof operated within the spaceport, a spaceport may be classified as:

(a) vertical spaceport,
(b) horizontal spaceport, or
(c) multimode spaceport.

***Space traffic management**[48]
In the EU framework, STM is defined as the 'means and rules to access, conduct activities in, and return from outer space safely, sustainably and securely. STM relates to the following elements: a) Space Situational Awareness (SSA) activities, including Space Surveillance and Tracking (SST); and b) orbital debris mitigation and remediation; c) management of space orbits and radio spectrum; d) the entire life-cycle of space operations including launch phase, in-orbit operations of spacecraft, and end-of-life

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[45] EASA website (interpretation of Art. 2(7) of Regulation 2018/1139 and Eurostat "Reference Manual on Air Transport Statistics" 2015 - The EASA HAO TF has recommended different definitions to distinguish between occupants, passengers and participants - See HLRN document from the Task Force

[46] A reusable suborbital vehicle may be part of a system which contains other parts which are expendable

[47] REGULATION (EU) 2021/696 of the European Parliament and of the Council of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme

[48] Joint Communication from the Commission and the High Representative to the European Parliament and the Council on "An EU Approach for Space Traffic Management" 15.2.2022 JOIN(2022) 4 final

de-orbit operations; e) re-entry phase of spacecraft into the airspace (both controlled and uncontrolled)'.

Stratoport

A site on the Earth's surface whose infrastructure, facilities and equipment, as well as its technical requirements, are specifically dedicated to launch/take-off, re-entry/landing, or ground/flight operation high-altitude platform systems (HAPS) operations.

Suborbital operation[49]

ICAO

"A sub-orbital flight/operation is a flight up to a very high altitude transiting temporarily through (sub)orbital space in the course of an earth- to-earth transportation and which does not involve sending the vehicle into orbit"

Or

EASA HAO TF

"A sub-orbital operation is an operation intended to carry out in the higher airspace a suborbital flight, whose Instantaneous Impact Point (IIP)[50] does not leave the Earth's surface (i.e., the vehicle is not able to reach and maintain orbital speed around the Earth) and which does not have the aim to place the suborbital vehicle into orbit in outer space.

A suborbital flight may be either:

(a) a flight such that in a portion of the flight path the vehicle is not able to develop sufficient aerodynamic forces to significantly affect the flight (ballistic flight), or
(b) a trans-atmospheric flight.

Trans-atmospheric flight

A flight transiting through the atmosphere up to high altitude, in which the vehicle is able to continuously use air-breathing propulsion, or is able to continuously use aerodynamic forces to control the flight (hypersonic flight), (note: no ballistic phase).

***Unmanned free balloon**[51]

Means a non-power-driven, unmanned, lighter-than-air aircraft in free flight.

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[49] Inspired by the outcome of the work of the ICAO Legal Committee December 2015, LC/36-WP/3-2 20/10/15

[50] Instantaneous Impact point means a predicted impact point following thrust termination of a vehicle or part of it, in a specific instant during flight.

[51] Commission implementing Regulation (EU) 373/2017 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight,

ANNEX 3 - ACTIONS LIST with timeline and effort (Option I)

OPTION I							RESOURCES 2023-2027			
				TIMELINE						
No	ACTION	DELIVERABLE	OWNER	Starting date	Ending date	Dependency	Manpower	Hours	Manpower cost (av. internal EASA cost 200 euro/hour)	Other costs (external studies)
SUPPORT TO INDUSTRY DEVELOPMENTS										
1	Pre-application contracts	2 pre-application contract reports per year	EASA	On-demand (as of mid-2023)	2 years after pre-application	None	Average of 400 hours per contract (to be charged to individual applicants under Fees and Charges Regulation)	800	€160,000	
2	Development of special conditions for the certification/validation/approval of new HAO aircraft/engine designs	2 sets of Special conditions	EASA	On-demand (as of mid-2023)	2 years after application	None	Average of 1000 hours per application (to be charged to individual applicants through Fees and Charges Regulation)	1000	€200,000	
3	Publish a HAO webpage on EASA's website with FAQs, contact point, useful material and links	EASA webpage	EASA	Mar-23	Apr-23	Approval of the Roadmap	6man/days in 2023	50	€10,000	
BUILD REGULATOR's KNOW-HOW AND RAISE AWARENESS										
4	Support to HAO tests and demonstrations through guidance on 'regulatory sandboxes'	4.A GM on regulatory sandbox	EASA	Mid 2023	End 2023	None	20m/days in 2023	160	€3,200	
		4.B Participation/support to tests	EASA	As of mid-2023	Continuous	In parallel to Action 4B	10 man/days/year	400	€80,000	
5	Awareness raising on HAO in the Agency to ensure that implementing or delegated acts do not prevent HAO when they are drafted or amended;	Internal awareness events (e.g. lunch time webinars)	EASA	As of 2023	Continuous	None	1man/day/year	40	€8,000	
6	Progressive competence building and training for EASA and Member States' staff	Leaflet on HAO A dedicated EASA webpage with a contact point Library on HAO accessible to external stakeholders EASA contact point for information	EASA	As of 2023	Continuous	None	5 man/day/year	200	€40,000	
7	Creation/maintenance of a network of EU HAO stakeholders	List of EU governmental HAO stakeholders List of EU industry/non-governmental HAO stakeholders 1 meeting + meeting report per year	EASA/COM	By mid 2023	Continuous	None	7 man/days in 2023 2 man/days for following years	120	€24,000	
8	Improve occurrence reporting on HAO	New/specific entry in ECCAIRS	EASA	Mid 2023	Mid 2024	None	2 man/days in 2023	16	€3,200	
9	Literature review on HAO and related new technologies (from total aviation system perspective)	Literature review and analysis	EASA	Mid-2023	Mid 2024	None	10 man/days in 2023	80	€16,000	

CONDUCT SCIENTIFIC STUDIES

10	**Launch of specific scientific studies to support future regulatory work, e.g.** - Regular updates of demand analysis - Study on CNS needs and capacities in Higher Airspace (incl. suitability of existing CNS capabilities and potential alternative means) - Study on the Assessment of the capability of SST sensors to provide surveillance services in HA - Study on the impact of HAO on human health (pilots, crew), including stress levels + liaison with the ESA to gain knowledge of medical standards and examinations for suborbital and space operations - Study on HAO frequency/spectrum needs - Study on the availability of MET and space weather forecast for the higher airspace - Study on the medical standards/requeirements criteria to be defined to allow HAO passengers to fly - Study on societal acceptance of HAO - Study on the efficient civil-military collaboration in the HA	Study reports	COM/EASA/SESAR/CLEAN AVIATION/INEA/EDA	Early 2024	End 2025	Endorsement of the Roadmap	Management/participation/monitoring by EASA: 30 man/days/year	1200	€480,000	€3,000,000

CONDUCT LEGAL AND REGULATORY ASSESSMENTS

11	**Detailed legal analysis of 'hybrid vehicles' and their applicable legal regime**	Study report	EASA/COM	Mid 2023	Mid 2024		60 man/day	480	€96,000	
12	**Analysis of Basic acts (BR + SES) to assess their scope and applicability to HAO and prepare future amendments if and when needed.**	Assessment report and draft amendments	EASA/COM	As of 2024	2026		60 man/days/year for all studies	120	€24,000	
13	**Detailed regulatory gap analysis and impact assessment on safety /sustainability regulations, incl.** -Assessment of the safety risks/objectives of envisaged HAO operations, incl. the possible applicability of the SORA methodology - Assessment of the security and cyber-security risks of HAO - Assessment of the environmental and noise impact of HAO (e.g. (green houses gas emissions, impact on the ozone layer, etc.)	Gap analysis report	EASA	As of mid 2024	Mid- 2025	Partial Results of Action 9 + Outcome of Action 4B	110 man/days	880	€176,000	€200,000
14	**Gap analysis on other EU regulations on civil aviation (internal market)**	Gap analysis report	COM	As of mid-2024	End 2025	Results of Action 9	tbc			

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LINK/SYNERGIES WITH OTHER EU POLICIES										
15	Liaise with DG DEFIS and EUSPA	Continuous coordination and improvement	EASA/COM	As of mid-2023	Continuous	None	4 man/days per year	160	€32,000	
16	Improve the EUSST re-entry service for its use by aviation	Continuous coordination and improvement	EASA/COM	As of mid-2023	Continuous	None	4 man/days per year	160	€32,000	
17	Ensure coherence of regulations STM/ATM	2 meeting reports/year	EASA/COM	As of mid-2023	Continuous	None	4 man/days per year	160	€32,000	
18	Liaise with EMSA	Various meetings + insertion in policy papers	COM/EASA	As of mid-2023	Continuous	None	4 man/days per year for each	160	€32,000	
19	Liaise/cooperate with military authorities: EDA, NATO	Various meetings + insertion in policy papers	COM/EASA	As of mid-2023	Continuous	None	2 man/days per year for each	80	€16,000	
20	General policy and strategy	2 meetings/year	COM/EASA	As of mid-2023	Continuous	None	4man/days per year	160	€32,000	
ENSURE REGIONAL AND GLOBAL INTEROPERABILITY										
21	Promote a European Regional approach Liaise with ICAO RO Paris and non-EU European States	2 meetings per year	EASA/COM	As of 2023	Continuous	Endorsement of the Roadmap	4 man/days per year	160	€32,000	
22	Contributing to HAO interoperability at global level (ICAO) -Monitor follow-up of Resolution A41-9	Meetings and reporting to the MAB	EASA/COM	As of 2023	Continuous	None	4 man/days per year	160	€32,000	
23	Coordinate with UNOOSA	Organise a meeting	EASA/COM	Mid 2023	Mid 2023	Endorsement of the Roadmap	2 man/days in 2023	15	3000	
	TOTAL *(average hourly cost: 200€)*							6761	€1,193,400	€3,200,000

ANNEX 4
GANTT CHART

No	Action	Start	Finish
1	Pre-application contracts	7/3/2023	6/30/2025
2	Development of special conditions for the certification/ validation/approval of new HAO aircraft/engine designs	7/3/2023	6/30/2025
3	Publish a HAO webpage on EASA's website with FAQs, contact point, useful material and links	3/1/2023	3/31/2023
4	Support to HAO tests and demonstrations through guidance on 'regulatory sandboxes'	7/3/2023	12/29/2023
5	Awareness raising on HAO in the Agency to ensure that implementing or delegated acts do not prevent HAO when they are drafted or amended;	1/2/2023	12/31/2030
6	Progressive competence building and training for EASA and Member States' staff	1/2/2023	12/31/2030
7	Creation/maintenance of a network of EU HAO stakeholders	7/3/2023	12/31/2030
8	Improve occurrence reporting on HAO	12/11/2023	2/12/2025
9	Literature review on HAO and related new technologies (from total aviation system perspective)	7/3/2023	9/4/2024
10	Launch of specific R&D/scientific studies to support future regulatory work	1/1/2024	12/31/2025
11	Detailed legal analysis of 'hybrid vehicles' and their applicable legal regime	1/1/2024	12/31/2024
12	Analysis of Basic acts (BR + SES) to assess their scope and applicability to HAO and prepare future amendments if and when needed.	1/1/2024	12/31/2026
13	Detailed regulatory gap analysis and impact assessment on safety /sustainability regulations	9/5/2024	9/5/2025
14	Gap analysis on other EU regulations on civil aviation (internal market)	9/5/2024	2/18/2026
15	Liaise with DG DEFIS and EUSPA	7/3/2023	12/31/2030
16	Improve the EUSST re-entry service for its use by aviation	7/3/2023	12/31/2030
17	Ensure coherence of regulations STM/ATM	7/3/2023	12/31/2030
18	Liaise with EMSA	7/3/2023	12/31/2030
19	Liaise/cooperate with military authorities: EDA, NATO	7/3/2023	12/31/2030
20	General policy and strategy	7/3/2023	12/31/2030
21	Promote a European Regional approach	4/3/2023	4/1/2031
22	Contributing to HAO interoperability at global level (ICAO)	1/2/2023	12/31/2030
23	Coordinate with UNOOSA	7/3/2023	7/31/2023
24	Update: 2019/947, 2019/945, 748/2012, 1321/2014, CS25, CS31, 1035/2011, 1034/2011, 2015/340, 1332/2011, 923/2012, 2017/ 273, 2019/123, 2150/2005, 139/2014, 1178/2011, 965/2012	9/8/2025	9/8/2027
25	Possibly develop non-binding guidance for stratoports and spaceports not falling under EASA's scope	1/1/2026	1/1/2027
26	Develop HAO personnel related training	9/9/2027	10/8/2027
27	Assess and update BASA agreements and TIPs if needed	9/9/2027	10/8/2027