IEEE Aerospace and Electronic Systems Society

The FALCON Innovation Program: A Flagship AESS Initiative Addressing Trusted Autonomous and Sustainable Aerospace Systems

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Executive Summary

The FALCON initiative represents a transformative research and training program established by the IEEE Aerospace and Electronic Systems Society (AESS) to tackle the pressing challenges and opportunities in the global aviation and commercial spaceflight industries. Focused on advancing trusted autonomous systems, sustainable aviation technologies, and advanced concepts in air and space transportation, the FALCON Initiative is designed to catalyze innovation and foster international collaboration. Through cutting-edge research, professional training, and partnerships, the program aims to create a lasting impact on the aerospace sector, fully aligned with IEEE's and AESS's vision and core objectives. Building upon the "Autonomy for Sustainability" super-topic, the FALCON Initiative extends its reach by addressing pressing global aviation and spaceflight challenges. This has become critical as the aviation sector faces growing demands for decarbonization and operational efficiency, while the commercial space sector confronts the increasing risks and complexities of orbital mission sustainability, satellite constellations management, and space traffic coordination.

In the aviation domain, FALCON focuses on accelerating sustainable solutions, including Advanced Air Mobility (AAM), next-generation air traffic management systems, green propulsion technologies, and the integration of trusted autonomous systems into the global airspace. By aligning with industry initiatives such as Multi-Domain Traffic Management (MDTM) and by promoting the use of alternative fuels and electrified propulsion systems, the program seeks to address the urgent need to minimize the environmental footprint of air transportation, thereby supporting the global goal of net-zero carbon emissions for aviation by mid-century.

For the commercial spaceflight sector, FALCON provides a comprehensive framework to advance sustainable space operations. Key focus areas include managing the exponential growth of satellite constellations, reducing the proliferation of orbital debris, and developing collision-avoidance technologies and autonomous spacecraft systems. The program also emphasizes advancements in spacecraft technologies, innovations in reusable launch systems, and solutions for energy efficiency in space environments. These technologies are critical enablers for long-duration missions, as well as for ensuring the long-term viability of space-based Communication, navigation, and surveillance (CNS) infrastructure.

Led by the AESS Technical Operations Committee, the FALCON Initiative integrates efforts from all existing AESS Technical Panels (TPs) and Technical Working Groups (TWGs) to promote a unified approach toward addressing systemic challenges in aviation and spaceflight. The initiative fosters partnerships with prominent organizations, including NASA, ICAO, FAA, EASA, JARUS, and other IEEE societies/councils, as well as non-IEEE professional organizations. These include the RAeS, RIN, ION, and AIAA (including the timely task forces on High-Speed Flight and Sustainable Space Operations). These partnerships strengthen FALCON's global reach, align its goals with industry priorities, and ensure that its outcomes are relevant and impactful.

In addition to its focus on technological innovation, the FALCON Initiative emphasizes the importance of cultivating future leaders in the aerospace industry. By providing workshops, professional training programs, and outreach initiatives designed to inspire and prepare the next generation of engineers and researchers, the initiative ensures a continuous pipeline of skilled professionals capable of addressing future challenges in aviation and space systems.

The FALCON Initiative is deeply rooted in the guiding principles and strategic goals of the IEEE and AESS. It leverages the Society's tradition of promoting multidisciplinary innovation, fostering knowledge sharing, and addressing critical engineering challenges to advance areas of global importance. Fully aligned with the findings from the Delphi Survey (Phase 1), the initiative represents a forward-thinking effort to solidify IEEE's position as a global leader in aerospace systems engineering, sustainability, and the integration of intelligent autonomous technologies.

Through this flagship program, AESS reaffirms its commitment to advancing aerospace technologies that not only tackle the dual challenges of sustainability and safety (through trusted automation and autonomy) but also support the rapid evolution of commercial aviation and spaceflight industries. In doing so, the FALCON Initiative ensures these domains continue to thrive as key drivers of economic growth, technology innovation, and humanity's collective progress towards a more sustainable future.

1. Background

1.1 Current Aviation and Spaceflight Evolutions

A transformation is occurring in the hitherto separate domains of the atmospheric and orbital flight. On one side, the increasing number and variety of crewed and uncrewed vehicles at lower altitudes is prompting a holistic revision of Air Traffic Management (ATM) services. On the other, commercial space travel is on a steady growth, with a rapid increase in number and variety of space-faring vehicles traversing various layers of the atmosphere, while large-scale networks of satellites already orbit our planet (Fig. 1). While these evolutions outline a dynamic future with a great variety of services and opportunities for transportation, communications and exploration, they also pose a significant challenge: the pressing need for a cohesive approach to manage traffic across all these flight domains guaranteeing safety, efficiency, and sustainability, thereby calling for the establishment of a Multi-Domain Traffic Management (MDTM) framework [Thangavel et al., 2021].

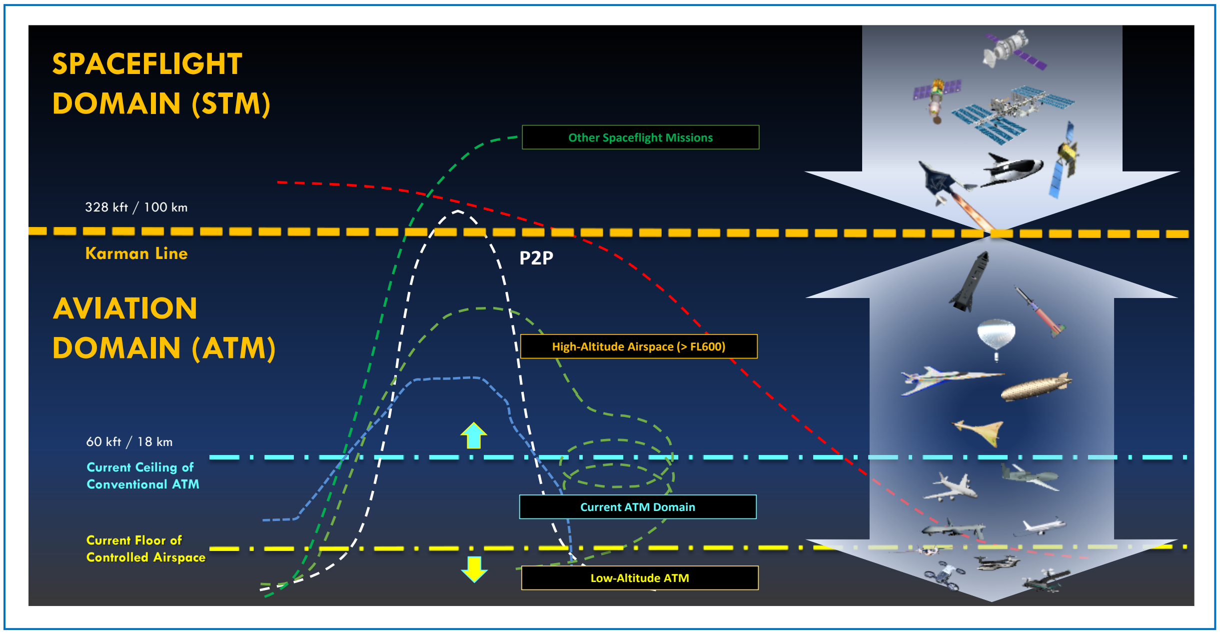

Fig. 1. Evolving aviation and spaceflight domains.

The existing systems and services are, in fact, fragmented, isolated, and responsive only to immediate events, thereby facing difficulties in accommodating more dynamic environments. The field of ATM is already dealing with the proliferation of Uncrewed Aircraft Systems (UAS) in the lower airspace [Sabatini, 2016], [Chen et al., 2024], [Dalmau et al., 2022], while the emerging Space Traffic Management (STM) framework is confronted with a pressing challenge of coordinating the rapidly expanding orbital operations [Hilton et al., 2019]. Unharmonized advances on these two fronts force us to maintain a segregation-based management paradigm, which is increasingly impactful to regular operations and prevents economies of scale in the integration of traffic and weather surveillance services, exposing us to greater risks of congestion, unnecessary environmental impacts and potential collisions. It is therefore critical to move away from temporary solutions towards a fully integrated and harmonized Air and Space Transportation (A&ST) system.

1.2 Aviation Sector Overview

The aviation industry plays a crucial role in the global economy. As reported by ATAG (2024), the sector contributed US$3.5 trillion to global GDP (4.1%) and supports 87.7 million jobs worldwide. Over the past several decades, the aviation sector has experienced an almost uninterrupted trajectory of exponential growth, demonstrating extraordinary resilience to economic fluctuations and geopolitical challenges. Its importance as a catalyst for economic activity is projected to expand significantly in the coming years. By 2038, global air transport is expected to support 143 million jobs and contribute $6.3 trillion to the global economy. However, such growth comes with considerable challenges. Historical data indicates that air traffic doubles approximately every 25 years [ICAO, 2019; ICAO, 2023]. Without strategic intervention, the aviation industry is projected to account for 5–10% of all human-induced climate change by 2050 [Lee et al., 2010]. Moreover, by mid-century, half of all global air traffic is expected to take off, land, or transit through the Asia-Pacific region (Fig. 2). These facts emphasize an urgent need for the industry to adopt sustainable practices that ensure the protection of the environment, address climate change concerns, and support affected communities. Balancing economic growth with sustainability and social responsibility will be critical to the sector's long-term viability and its contribution to global development.

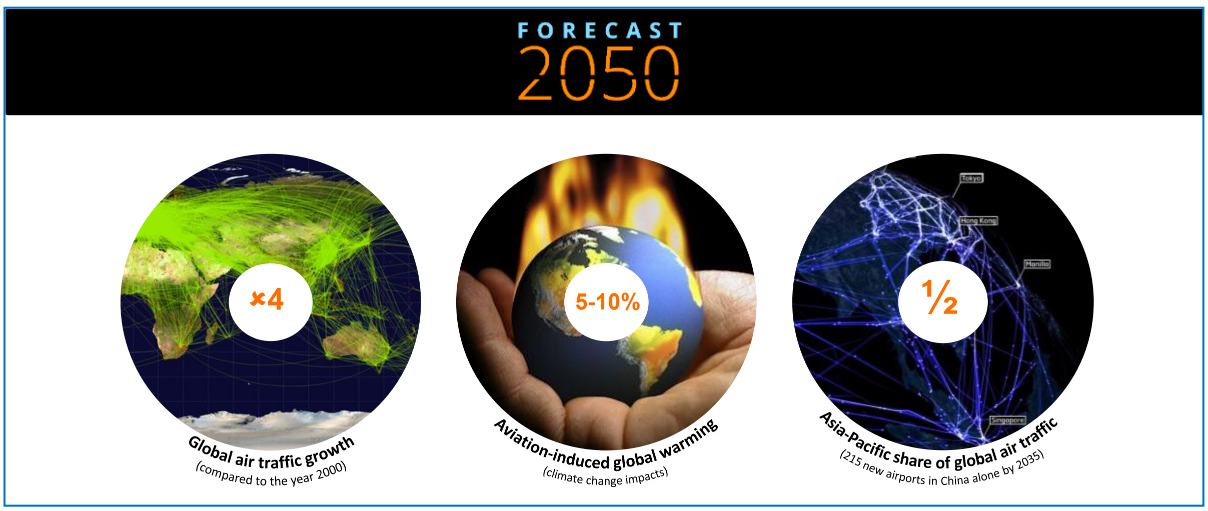

Figure 2. Aviation sustainability challenges.

Over the years, the aviation sector has faced intense and growing pressures due to several economic, technological, and environmental factors, including rising operational and fuel costs, increased global competition due to market liberalization, an upsurge in air traffic, capacity constraints at major airports, and the urgent need to enhance environmental sustainability in both airport and aircraft operations. Additionally, new regulations aimed at accommodating next-generation, technologically advanced aircraft necessitate updated maintenance needs and operational dynamics.

To continue its pivotal role in supporting global economic development and employment, the aviation sector must evolve to become more customer-centric, efficient, secure, and environmentally sustainable. A primary focus is the swift adoption of digital flight systems and ground-based infrastructure, which can enable higher levels of automation, improve airspace capacity, and significantly enhance sustainability for both passenger and cargo air transportation. Over the past two decades, ambitious international environmental sustainability targets have been set for the aviation industry, such as halving greenhouse gas

(GHG) emissions by 2025 (relative to 2000 levels) and achieving carbon neutrality by 2050 [Lee et al., 2010], [ACARE, 2012], [ACARE, 2022]. Rising fuel costs, having increased fourfold over the past decade, have further pressured airlines and general aviation companies to improve efficiency and sustainability, with estimated passenger traffic within Asia alone expected to grow by 10% annually [Boeing, 2013], [Boeing, 2017], [Boeing, 2020].

Fluctuations in air transport demand (passenger and cargo services) are one of the main drivers affecting the aerospace engineering sector's profitability. In 2019, the global aerospace market reached a value of approximately US$342 billion, growing at an annual rate of 3.1% since 2015 but later experiencing downturns before resuming growth. Currently, the market is recovering at a compound annual growth rate (CAGR) of 9.8% and is forecasted to reach $442.25 billion by the end of 2026 at a CAGR of 12.9% [TBRC, 2022]. Factors likely to accelerate market growth include a rising demand for commercial Unmanned Aircraft Systems (UAS) and Advanced Air Mobility (AAM) services, technological advances in eco-friendly design solutions (e.g., aerospace vehicles, propulsion, digital flight systems, and ground-based infrastructure), and the continued adoption of sustainable aviation technologies along with developments in legal frameworks, certification standards, and operational procedures. In the rapidly advancing AAM context, significant emphasis has been placed on electric and hybrid-electric Vertical Takeoff and Landing (VTOL) vehicles and associated systems (Fig. 3).

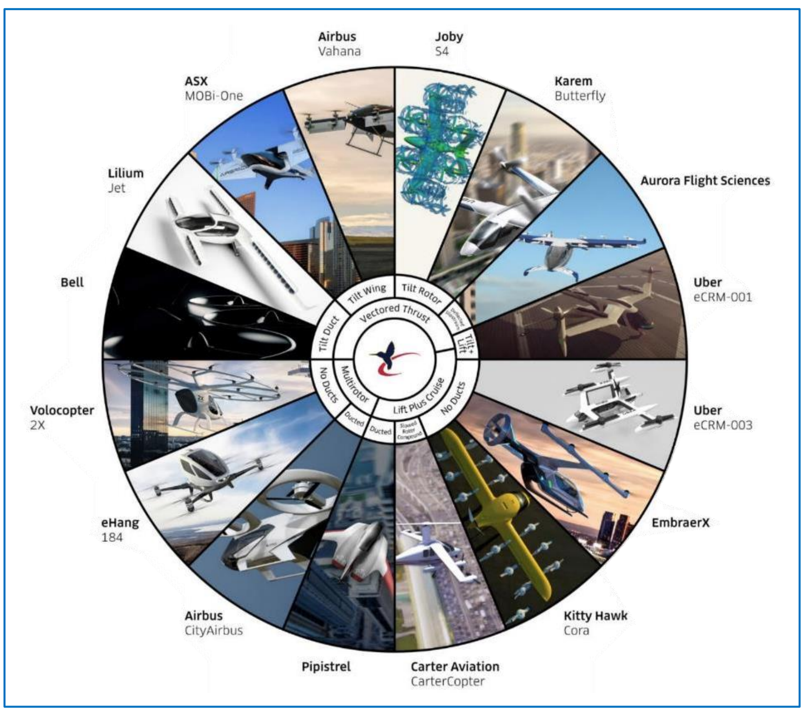

Figure 3. Some of the proposed eVTOL concepts (Filipenko, 2020).

Furthermore, the expansion of commercial aviation above Flight Level 600 (FL 600) is poised to drive further evolution and growth in the aviation and aerospace sectors [FAA, 2020]. To date, Upper Class E airspace operations have been limited in scope due to the inherent challenges of flying in a low-density atmosphere above FL600 (Fig. 4). Recent advances in power and propulsion, aircraft structures, avionics systems and aerodynamics are allowing the development (and initial deployment) of both manned and unmanned aircraft that overcome these limitations.

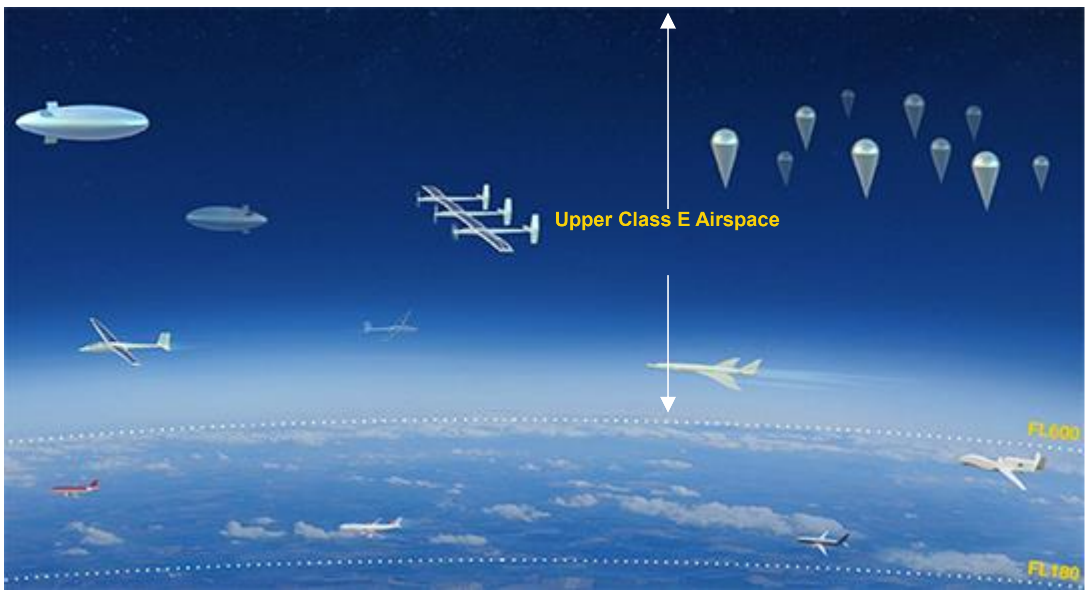

Figure 4. Upper Class E Airspace and Flight Platforms (NASA, n.d.).

These new aircraft types can fulfil a variety of civil and military requirements, including wide area Earth observation, telecommunications, supersonic passenger flight, defense ISR (intelligence, surveillance and reconnaissance), and several R&D missions. Regulations and standards are now evolving to support safe operations in Upper Class E airspace [FAA, 2020], [EASA, 2023] and Upper-Class E Traffic Management (ETM) has emerged as an essential capability, requiring a seamless integration with current and future ATM operations. While multiple use cases and business opportunities are clearly emerging, environmental sustainability aspects must be carefully considered as well.

From a platform perspective, both high-speed flight (supersonic and hypersonic vehicles) and High-Altitude Pseudo Satellites (HAPS) are receiving much attention for operations above FL600. Numerous civil and military use cases exist for high-speed flight vehicles, while HAPS are an attractive technology to fill the gap between terrestrial and space systems. These uncrewed platforms complement and extend the capabilities of satellites found in Earth observation, telecommunications and navigation, offering unique capabilities for the development of value-adding applications and science.

1.3 Commercial Spaceflight Evolutions

Parallel developments in spaceflight research have led to the emergence of reusable manned and unmanned space vehicle concepts, creating opportunities for a nascent space transport sector. Within this extended operational context, the *Fédération Aéronautique Internationale* (FAI) defines Point-to-Point Space Transport (P2PST) as a flight conducted in an aerospace vehicle that surpasses an altitude of 100 km (62 miles), marking the Kármán Line the recognized boundary between Earth's atmosphere and outer space [22]. In other words, refers to a mode of transportation that utilizes space-based or suborbital flight trajectories to rapidly transport passengers or cargo between two spatially distant locations. Unlike conventional terrestrial or orbital missions focused solely on orbit insertion or exploration, P2PST is primarily intended for high-speed, long-distance travel that begins and ends at distinct points on Earth.

Clearly, for this sector to be commercially and technically viable, it must provide an acceptable level of safety via innovative digital tools, such as mission planning and decision support systems. These technologies rely on advanced Communication, Navigation, and Surveillance (CNS) to integrate space operations into the current Air Traffic Management (ATM) framework seamlessly. Despite the high maturity of propulsive and vehicle technologies, challenges persist in adopting intelligent and autonomous systems to merge P2PST with conventional atmospheric air travel [Hilton et al., 2019], [Sabatini and Gardi, 2023].

Table 1 lists the leading actors in this field. Suborbital transport utilizes vehicles capable of breaching the Kármán line (~100 km altitude) before re-entering the atmosphere and landing at a designated location. These systems are broadly categorized into three architectures: Vertical Takeoff-Vertical Landing (VTVL); Horizontal Takeoff-Horizontal Landing (HTHL); and hybrid systems that integrate elements of both.

Table 1. Some prominent actors in P2PST.

Space Vehicle	Strato launch	Virgin Galactic SpaceShip2	SNC Dream Chaser	Radian Aerospace Radian 1	Skylon Reaction Engines	Blue Origin New Shepard	SpaceX Starship
Image							
Type	Mothership Horizontal Takeoff/Horizontal Landing	Mothership Horizontal Takeoff/Horizontal Landing	Single Stage Horizontal Takeoff/Horizontal Landing	Single Stage Horizontal Takeoff/Horizontal Landing	Single Stage Horizontal Takeoff/Horizontal Landing	Heavy Lift Vertical Launch and Return	Heavy Lift Vertical Launch and Return
Relative Payload Capacity	6,123 kg	589 kg	4.989 kg	2.267 kg	16.782 kg	408 kg	99.790 kg

VTVL systems, such as SpaceX's Starship, employ reusable rocket boosters to ascend vertically before a controlled descent and landing. This design benefits from high thrust efficiency but necessitates robust thermal protection and precise landing mechanisms. HTHL systems, exemplified by the historical Space Shuttle and modern concepts like Sierra Space's Dream Chaser and Virgin Galactic Spaceship 2, utilize a runway-based approach for both take-off and landing, reducing infrastructure requirements but demanding advanced aerodynamics and propulsion efficiency. Hybrid systems combine vertical launch with horizontal recovery, offering flexibility but introducing engineering complexities in propulsion and structural integration. The different types of P2PST missions and their respective mission phases are illustrated in Fig. 5.

Numerous studies have been conducted on viable launch and re-entry methodologies, revealing both physical and computational challenges, while exploring the potential for future commercial space transport operations [Vozoff and Couluris, 2008], [Krevor et al., 2011], [Longstaff and Bond, 2011]. Recent research is now increasingly focused on the unique hazards of the space environment during the on-orbit phase and the necessary strategies for deconfliction and collision avoidance [Hilton et al., 2019]. The successful development of unsegregated P2P space transportation requires regulatory evolution and robust government support for establishing new Sustainable Business Models (SBM). These models must address operational risks, liability, space debris mitigation, and airspace management. Additionally, to fully integrate new entrants (including drones and other autonomous platforms) into existing airspace, extensions or alternative approaches to current air traffic management (ATM) and air traffic flow management (ATFM) are urgently needed. This evolving framework must also include dynamic on-orbit risk management strategies.

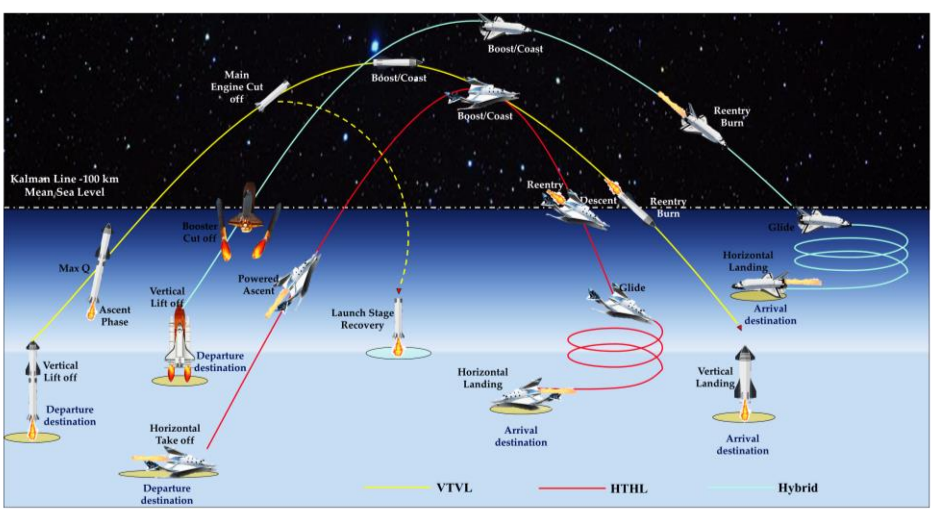

Figure 5. Different types of P2PST systems.

Emerging trends in both atmospheric and suborbital flight are redefining airspace usage (Fig. 6), raising new legal and technical challenges insufficiently addressed by current regulatory frameworks such as those of the International Civil Aviation Organization (ICAO) and the Committee on Peaceful Uses of Outer Space (COPUOS) [Haley, 1963], [Harris, 2006], [Monahan, 2008], [Bittencourt Neto, 2015], [McDowell, 2018].

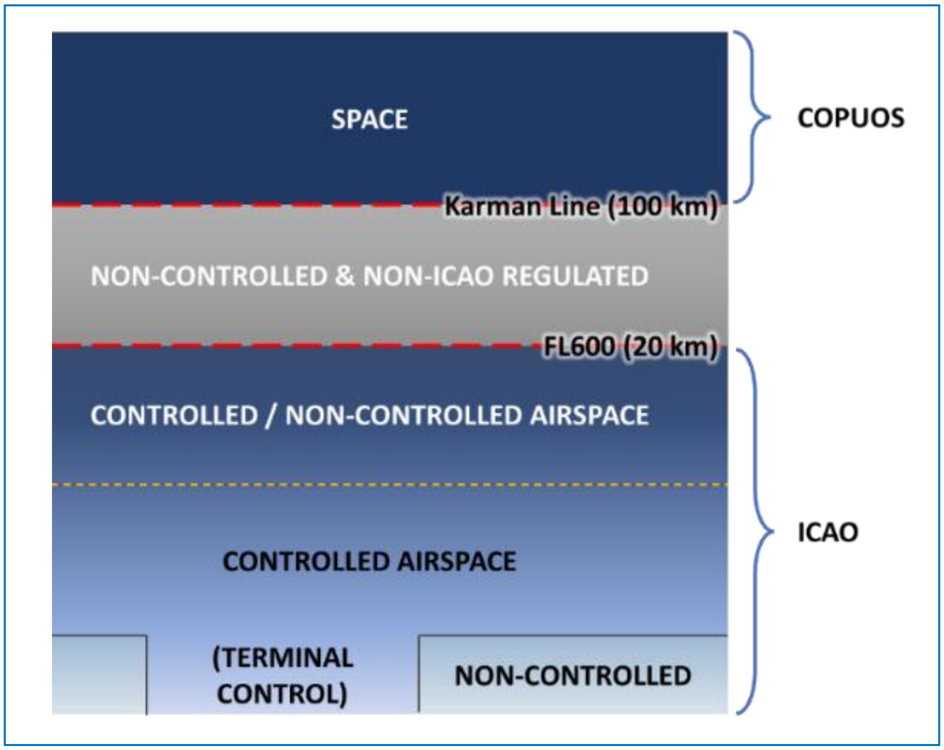

Figure 6. Evolving airspace definitions.

The coexistence of manned and unmanned platforms, including autonomous ones, necessitates a more integrated air-and-space traffic management system with significantly higher automation than present-day ATM solutions. Integrating conventional ATM with emerging Unmanned Traffic Management (UTM) and Space Traffic Management (STM) systems will enable the flexibility required to support sustainable growth. The fusion of these management systems into a Multi-Domain Traffic Management (MDTM) framework promises to address challenges such as collision avoidance and airspace coordination, while enabling seamless operations in previously unsegregated domains of airspace (e.g., between 20 km altitude and the Karman line at 100 km) [Sabatini et al., 2019]. This evolving MDTM framework (Fig. 7), supported by updated ICAO and COPUOS regulations, will allow the aviation and spaceflight sectors to safely and sustainably grow by supporting both manufacturers and service providers [Sabatini, 2017].

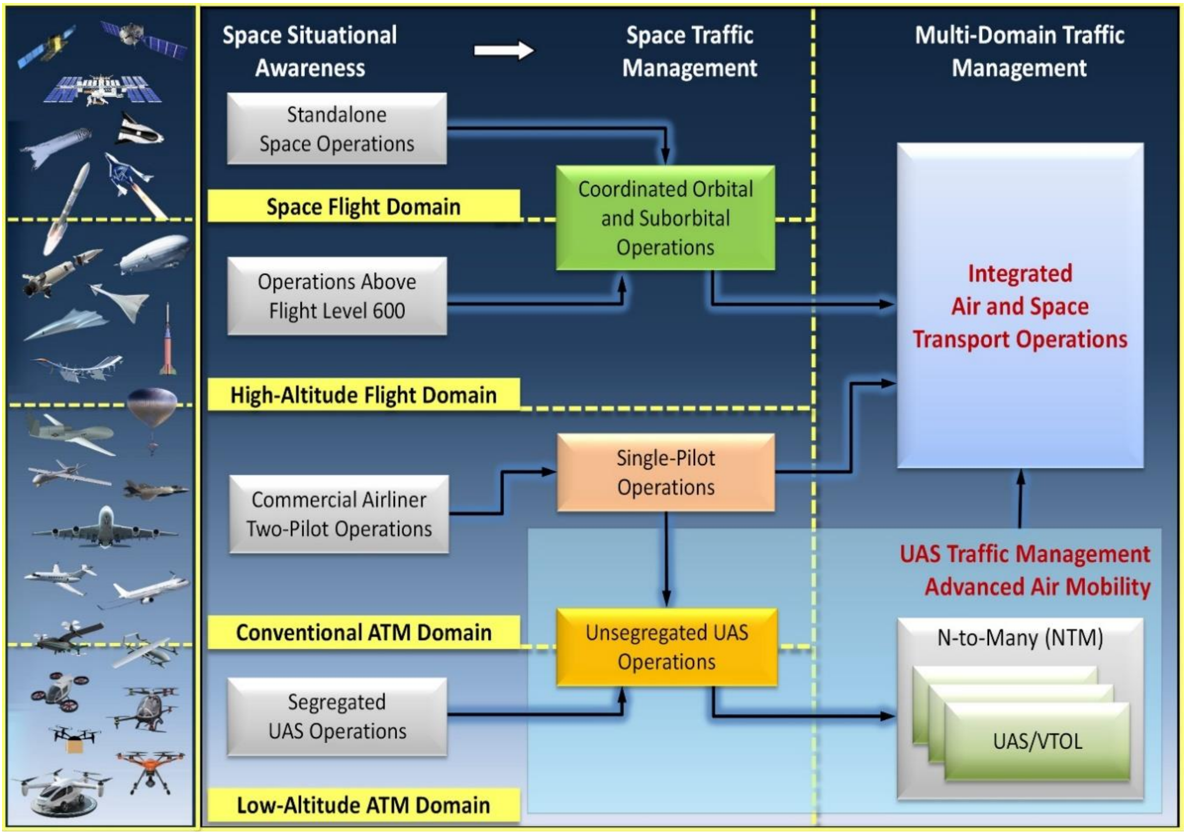

Figure 7. Evolving air and space traffic management systems. Adapted from Sabatini et al. (2020).

As digital innovations continue to disrupt and evolve the A&ST sector, aerospace systems are rapidly becoming more intelligent and capable of autonomous operations. This shift underscores the importance of the Tertiary Education Sector (TES), including both higher education and vocational institutions, in training the next generation of engineers and technologists to tackle the challenges and leverage the opportunities of emerging flight systems. A multidisciplinary, research-focused approach is required to achieve industrial adoption of advanced technologies while addressing their safety, security, and ethical considerations. Beyond technology, the transformation of the A&ST sector demands updated regulations, innovative business strategies, and sustainable lifecycle-focused management models.

Partnerships among government agencies, industry players, and the research community are critical for overcoming challenges and fostering the development of SBMs tailored to the evolving industry. Priority areas identified globally and within regions such as the UAE include [Sabatini and Gardi, 2023]: (1) rapid uptake of fuel-efficient and low-emission technologies, alternative energy solutions, and multimodal transport integration to boost airport and aircraft operational efficiency and sustainability, and (2) pervasive adoption of digital technologies to evolve Digital Business Models (DBM). These transformations will harness interconnected Cyber-Physical Systems (CPS), Artificial Intelligence (AI), and digital twins for enhanced operations. Embedding new safety protocols, flight optimization technologies, and decision support systems in ATM and ATFM is essential to meet growing demands sustainably and safely.

The A&ST sector's long-term growth will benefit from a strategic roadmap that emphasizes workforce development, integrated system-of-systems approaches, and strengthened collaboration among stakeholders in the wider ecosystem. The safe growth of this increasingly interconnected airspace will require new cyber-physical frameworks for safety and security, particularly in low-level airspace and around urban areas, where commercial UAS and AAM operations will become commonplace. Addressing these challenges will position the A&ST sector to leverage global opportunities, develop new products and services, and significantly boost its contribution to economic prosperity and job creation worldwide.

2. AESS FALCON Initiative Overview

2.1 Mission and Vision

The AESS FALCON Initiative serves as a strategic, global framework for fostering innovation and sustainability across aviation and spaceflight domains. It partners with industry, academia, and government entities to develop cutting-edge aerospace systems, nurture a skilled global workforce, and advance translational research.

Mission: *To lead transformative advancements in sustainable aerospace technologies, trusted autonomous systems, and integrated air and space traffic management by leveraging industry-focused research, fostering international collaboration, and aligning efforts across IEEE's global network. Through these efforts, the initiative aims to achieve measurable progress in decarbonizing aviation, ensuring orbital sustainability, and accelerating the adoption of resilient aerospace solutions that meet future global needs.*

Vision: *To establish a unified and influential IEEE-led global network that drives industry-focused innovation and research excellence in aviation and spaceflight. The initiative envisions a future where advancements in sustainability, safety, trusted autonomy, and accessibility redefine aerospace systems, ensuring that these technologies contribute to the well-being of society, foster economic growth, and enable humanity's progression toward a more sustainable and interconnected world.*

2.2 Alignment with IEEE's Autonomy for Sustainability Super-topic

The FALCON Initiative extends the work initiated under the Autonomy for Sustainability Super-topic, which focused on enabling autonomous capabilities for a sustainable future. By integrating technological advancements such as artificial intelligence, trusted autonomy, and sustainable flight systems, FALCON directly addresses key industry requirements.

This extension aligns seamlessly with recommendations from the Delphi Survey (Phase 1), which identified sustainable and autonomous aerospace systems as critical areas of future development. The AESS FALCON Initiative embodies these findings by focusing on four core objectives:

1. Enhancing aviation and spaceflight sustainability;
2. Enabling trusted automation and autonomous flight systems;
3. Advancing Multi-Domain Air and Space Traffic Management (MDTM); and
4. Fostering workforce development (upskilling and reskilling) on a global scale.

1.3 Strategic Objectives

1. **Unify IEEE Communities:** Leverage existing expertise and capabilities across IEEE Societies (AESS, IEEE Robotics and Automation Society, IEEE ITS Society, Transportation Electrification Council, and the AI Coalition) alongside the AIDA and AIAA communities.
2. **Sustainable Global Frameworks:** Advance global adoption of sustainable aviation technologies across emerging markets and developed nations.
3. **Advance Trusted Autonomy:** Serve as a global hub of research excellence for developing autonomous systems for urban air mobility (UAM), regional connectivity solutions, and high-speed flight applications.
4. **Develop Skilled Professionals:** Enhance global aerospace and air mobility workforce readiness through tailored training programs aligned with industry needs and expectations.

2. Synergistic Collaborations with IEEE and External Organizations

2.1 IEEE Societies and Initiatives

The initiative benefits from collaborations with leading IEEE Societies and other ongoing parallel initiatives. Key aspects include:

- **IEEE Intelligent Transportation Systems Society (ITS):** Joint research opportunities in vehicular technologies, connected vehicles/infrastructure (V2X), multimodal transportation systems, and sustainable transport solutions.

- **IEEE Robotics and Automation Society (RAS):** Integration of robotics and automation solutions for UAS design, ATM, AAM, and MDTM systems.
- **EEE Communications Society (ComSoc):** Join forces on advanced communication technologies, including 5G/6G, satellite communications, and secure data exchange applicable to complex air and space systems.
- **IEEE Power and Energy Society (PES):** Innovations in sustainable power systems and energy generation to enhance the environmental sustainability of aviation and spaceflight operations.
- **IEEE Society on Social Implications of Technology (SSIT):** Addressing ethical, social, and policy issues related to trusted autonomy, automation, and artificial intelligence in aerospace systems.
- **IEEE Vehicular Technology Society (VTS):** Contributions to autonomous and connected vehicle technologies, electric and hybrid propulsion systems, and mobility solutions for Advanced Air Mobility (AAM) ecosystems.
- **IEEE Geoscience and Remote Sensing Society (GRSS):** Advancing the use of geospatial and satellite data for environmental monitoring, orbital debris tracking, and space sustainability.
- **IEEE Electromagnetic Compatibility Society (EMC):** Researching interference mitigation and standards for electromagnetic compatibility to ensure the safe integration of autonomous aviation and space systems.
- **IEEE Microwave Theory and Techniques Society (MTT-S):** Pioneering high-frequency technologies and radar systems applicable to air and space traffic management, collision avoidance, and advanced communication.
- **IEEE Transportation Electrification Council (TEC):** Development of next-generation electric and hybrid-electric propulsion and energy management systems.
- **IEEE AI Coalition (AIC):** Collaboration in advancing intelligent and autonomous aerospace systems.
- **IEEE Standards Association (SA)**: Collaborating to establish industry standards for Advanced Air Mobility (AAM) systems, Uncrewed Aircraft Systems (UAS), and future spaceflight technologies.

2.2 Synergies with External Organizations

The AESS FALCON Initiative builds partnerships beyond IEEE, focusing on broadening interdisciplinary collaboration around initiatives including (but not limited to):

- **NASA (National Aeronautics and Space Administration):** Joint initiatives on advanced avionics, autonomous space systems, and AI-driven mission planning tools for space exploration and air systems.

- **UNOOSA (United Nations Office for Outer Space Affairs):** Collaboration to develop global standards for space sustainability, including debris mitigation and orbital traffic management practices.
- **FAA (Federal Aviation Administration):** Partnering on integrating emerging technologies into national airspace systems, including NextGen advancements and regulatory frameworks for spaceports.
- **ESA (European Space Agency):** Research on orbital debris tracking, planetary defense systems, and interoperability for global air and space traffic coordination.
- **SESAR (Single European Sky ATM Research):** Collaboration on air traffic management modernization initiatives focused on efficiency, safety, and integrating innovative aviation technologies.
- **NOAA (National Oceanic and Atmospheric Administration):** Collaboration on space-based observation systems for environmental monitoring, weather prediction, and disaster response through remote sensing.
- **ICAO (International Civil Aviation Organization): Joint** efforts on developing international guidelines for seamless integration of advanced air and space transportation systems into civilian airspace.
- **ITU (International Telecommunication Union):** Partnering on global radio-frequency management and standards for aerospace CNS and satellite communications, ensuring efficient use of the electromagnetic spectrum and supporting evolutionary aviation and spaceflight systems.
- **AIAA DATC (Digital Avionics Technical Committee):** Collaboration on advanced digital tools for avionics system development, air traffic automation, and human-machine interfaces.
- **AIAA High-Speed Task Force:** Joint research exploring the integration of high-speed air and sub-orbital transport into conventional airspace systems.
- **AIAA Task Force on Sustainable Space Operations:** Focused research on space domain awareness, High-Altitude Pseudo-Satellites (HAPS), and orbital/suborbital traffic management systems.

3. Organizational Structure

The FALCON Initiative is structured with oversight from the AESS Technical Operations Committee (TechOps), supported by the AESS Board of Governors. The governance structure includes an interdisciplinary team of researchers and leaders (industry, government, and academia) from fields spanning the entire spectrum of aerospace electronic systems, including digital avionics and space systems, aerospace sensors and multi-sensor data fusion, GNC, cyber-physical security, CNS and Air Traffic Management

(ATM) systems. These key enabling technologies are an integral part of the existing TPs and TWGs scope of work. FALCON will also establish an Industry Advisory Board (IAB) comprising permanent members of leading aerospace organizations and societies (not necessarily IEEE members), such as NASA, ESA, FAA, NOAA, EASA, CASA, CAA, ICAO, JARUS, and others.

4. Planned Activities and Key Focus Areas for Growth

1. **Global Competitions:** Annual challenges for student and professional teams to develop innovative solutions in sustainable aviation, autonomous technologies, and multi-domain traffic management.

2. **Certification Standards:** Collaborate internally with the IEEE SA and externally with global regulators such as ICAO, ITU, FAA, EASA, to establish standards for certifiable AI, Trusted Autonomous System (TAS), and sustainable aviation/spaceflight technologies.

3. **Outreach and Training:** Expand and nurture partnerships with IEEE Societies and Councils to offer conferences, webinars, and training programs that strengthen the aerospace community's capabilities worldwide.

5. Challenges, Opportunities, and Competitive Advantage

The FALCON Initiative operates within a rapidly evolving aerospace landscape, balancing the complexities of regulatory compliance, technological competition, and environmental challenges with the growing demand for sustainability and trusted autonomy. While navigating hurdles such as multi-jurisdictional standards, high development costs, and the integration of emerging technologies, it also leverages global opportunities in decarbonization, green propulsion, and autonomous traffic management. With access to IEEE's vast interdisciplinary expertise and extensive global network, the initiative enjoys a unique competitive advantage through its holistic approach that integrates technical, regulatory, and environmental solutions. By fostering inclusivity and cross-sector collaboration, FALCON positions itself as a leader in driving scalable, innovative, and sustainable aerospace advancements on an international scale.

6. Conclusion

The AESS FALCON Initiative represents a comprehensive and structured effort to address critical challenges in aerospace through the integration of trusted autonomy, sustainable technologies, and interdisciplinary collaboration. As an extension of the AESS Autonomy for

Sustainability super-topic, the initiative aims to redefine the future of flight by focusing on decarbonization, enhanced operational efficiency, and the sustainability of aviation and space systems. By leveraging contributions from the AESS TPs and TWGs, and external collaborators, the initiative seeks to develop solutions that address the complex interplay of flight safety, efficiency, and sustainability, both in the atmospheric and space operational domains. Its focus on rigorous research, engineering design/analysis methods, and scalable solutions positions it as a vital contributor to advancements in aeronautics and astronautics systems. The initiative's emphasis on fostering collaboration across domains and disciplines ensures a holistic approach to solving emerging global challenges. Its dedication to workforce development further enhances its scope by equipping current and future professionals with the knowledge and skills required to meet the evolving demands of the aerospace sector. In other words, the FALCON Initiative is designed to set a benchmark for scientific rigor and practical impact, contributing industry-relevant solutions to pressing global aerospace challenges. In doing so, it establishes the IEEE AESS as a central actor in driving innovation, shaping international standards, and leading the global transition toward a more sustainable and resilient aerospace future.

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