

UK Civil Aviation Authority

Signals and Trends related to Technology & Innovation in the Aviation Sector

November 2026

Foreword

In an environment characterised by rapid change, increasing complexity and continual disruption, organisations need more than hindsight and evidence to make informed decisions. They need a clear understanding of the emerging signals, trends and drivers that are shaping the future. This Signals and Trends Brief has been developed to support that need.

The UK Civil Aviation Authority, Strategic Research and Intelligence Team plays a critical role in identifying, analysing and interpreting the developments that have the potential to influence aviation's operating environment, stakeholders, priorities and long-term objectives. By bringing together evidence from a wide range of sources, the team provides forward-looking insight that helps decision-makers anticipate change, understand emerging risks and opportunities, and build resilience in an evolving landscape.

This briefing highlights the key signals and trends currently gaining momentum and considers their potential implications. While no single trend can predict the future, collectively these developments provide valuable indications of where change may occur and where strategic attention may be required. The intention is not to forecast a fixed outcome, but to encourage informed discussion, challenge assumptions, plan scenarios and support proactive planning.

As you review the insights presented in this report, we encourage you to consider how these signals may affect your areas of work, your stakeholders, and the decisions being made today. By combining evidence-based intelligence with strategic foresight, we can better prepare for uncertainty and position ourselves to respond effectively to emerging challenges and opportunities.

We hope this brief provides a useful resource for reflection, planning and action, and supports a culture of informed, future-focused decision-making across your organisation.



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How to use this report

- This report provides an overview of emerging signals and trends influencing aviation, aerospace, technology and innovation. These early indicators of change can help the CAA identify potential threats, opportunities, and areas requiring strategic attention.
- Readers should view these signals as indicators of possible change rather than predictions. Some may accelerate, others may stall, and new developments may emerge unexpectedly. The value lies not in forecasting a specific future, but in helping the organisation recognise uncertainty earlier and prepare more effectively.
- The report forms part of the CAA's Corporate Horizon Scanning framework. Signals and trends presented here are intended to act as the starting point for further analysis, discussion and monitoring across the organisation.
- Future editions will continue to expand the evidence base, enhance coverage and provide an increasingly comprehensive picture of the trends shaping aviation and its wider ecosystem.



Executive Summary

This quarter's analysis points to an aviation sector becoming increasingly interconnected, complex, and influenced by developments beyond traditional aviation.

The key signals explored in this report are:

- Resilience is rising up the agenda as GNSS disruption, geopolitical instability, and infrastructure constraints expose growing vulnerabilities across aviation and adjacent sectors. (see slide 6)
- Space and aviation are becoming increasingly connected, creating new regulatory, safety, security, and operational considerations as commercial space activity continues to expand. (see slide 7)
- The low-altitude economy is entering a phase of commercial growth, creating opportunities and regulatory demands across drones, BVLOS operations, advanced air mobility, and supporting service ecosystems. (see slide 9)
- Automation is moving into the physical world, with rapid advances in AI-enabled humanoid robotics beginning to influence operational environments, workforce planning, and future productivity. (see slide 11)
- Aviation's growth and decarbonisation ambitions are increasingly constrained by systemic capacity, infrastructure, fuel and geopolitical challenges, resulting in a growing reliance on operational optimisation measures while long-term sustainable technologies face continued delays and uncertainty. (see slide 13)
- Demand for batteries is accelerating, bringing significant opportunities for innovation alongside emerging safety, supply-chain, and compliance challenges. (see slide 14)

Collectively, these developments point towards an aviation ecosystem defined by greater technological convergence, growing interdependencies, and an increasing need for resilience. While the pace and trajectory of change remain uncertain, these emerging signals offer valuable insights into areas that may require strategic focus and preparedness.

This report explores each development in greater detail, examining its implications for aviation, aerospace, and the broader operating environment. In doing so, it supports the CAA's ongoing horizon-scanning programme, helping to identify emerging opportunities, risks, and challenges. By understanding these signals today, we can make better-informed decisions and build the capability needed to navigate the future with confidence.


Trends

1. Cybersecurity of Space-Based Aviation Infrastructure

The aviation sector is becoming increasingly dependent on satellite-enabled services, creating a highly interconnected operational environment. While this dependence has delivered significant improvements in efficiency and safety, it has also increased exposure to cyber disruption. As threats to space-based systems continue to evolve, strengthening resilience is becoming a strategic priority for both industry and regulators.

GNSS disruptions are increasing in both frequency and sophistication, with IATA reporting a significant rise in interference capable of compromising aircraft navigation systems. GPS jamming incidents, which disrupt navigation signals, increased by 67% in 2025, while spoofing attacks, where false signals are transmitted to mislead aircraft position and timing systems, rose by 193%. This trend is being driven, in part, by ongoing geopolitical tensions, with elevated levels of interference observed across the Middle East, Baltic Sea, Black Sea, and Eastern Mediterranean regions. Between January and April, 25% of flights operating in the eastern Baltic Sea experienced GPS disturbances, highlighting the growing vulnerability of global navigation infrastructure.

Opportunities and Challenges:

The risks highlighted extend well beyond aviation, reflecting an increasing civil-military reliance on space-based assets. Satellite systems underpin critical functions including navigation, communications, weather forecasting and defence operations. When these systems are disrupted, the effects can cascade across both civilian and military operations. As GNSS interference becomes more frequent, international efforts to strengthen resilience and develop alternative navigation capabilities are accelerating. Industry bodies and regulators, including IATA, EASA and ICAO, are enhancing standards, guidance and coordination, while investment in non-satellite navigation technologies continues to grow. In the UK, the government published its Resilience Action Plan alongside the National Risk Register and associated response requirements for space-based services.

The key challenge now is ensuring operational resilience through the rapid deployment of alternative technologies, stronger international coordination, and improved capabilities to counter evolving cyber threats from both state and non-state actors.

Year	Notable Regions	Key Highlights
2021	Eastern Europe, Middle East	Sporadic jamming near conflict zones
2022	Ukraine, Baltic Sea	Start of Russia-Ukraine war intensified interference
2023	Northeastern Europe, France, Ukraine, Netherlands	Russia-linked jamming in Northeastern Europe and Baltic states
2024	Gulf	IATA reports 500% spike in spoofing and interference rates increased by 175%
2025	Poland, Baltic States, Finland and Sweden	25% of flights in Baltic affected; vessels impacted in maritime sector

*Figures indicative; compiled from multiple industry sources

2. Trends in the Space Sector



Working with our Space Regulation team who continually monitor for emerging signals in this exciting sector, we have identified these four emerging signals.

	1. Very Low Earth Orbit (VLEO) Operations	2. Large Constellation	3. Space Planes	4. Global Security Situation
What is it?	Satellite operations at very low orbital altitudes (100-400km). Multiple operators looking to do it imminently.	Regulation of another large constellation (>100 satellites) by the CAA- repeated rumours and signals	Multiple efforts towards operating spaceplanes in UK jurisdiction- domestic and international.	Continued development of space as active warfighting domain and increased global instability, more government operated satellites, need for sovereign capability.
What are the challenges?	Current tracking and telemetry are not optimised for these altitudes, possibility of air-breathing engines being used-largely technical.	Resourcing for licensing/monitoring, technical and policy/political challenges around management/deconfliction	Quite different to regulation of horizontal, longer flight trajectories, spaceport usage challenges.	Bounds of civil/military regulation, changes to the way space is used, potential hostile action.
How are we intending to meet them?	Identification of key issues and challenges and planning for tackling these, potential for seeking HMG funding to assist with regulatory development.	Proactive engagement with government on policy issues, HMG-CAA sandbox on orbital licensing, internal processes development (re-using info etc)	Active monitoring and early engagement with prospective operators- active maintenance of relevant spaceport operators, engagement with HMG.	Working with MOD more closely on their missions, monitoring of procurement activity, tracking changing space trends and how they are impacting on us.

3. The Low Altitude Economy

What: According to the Bank of America's definition, the low-altitude economy (LAE) is an emerging economic sector focused on commercial activities, and services operating in airspace below 3,000 ft above ground level.

Drivers: Growth is primarily driven by the rise of eVTOL, and RPAS technologies, alongside public and private investment with Bank of America Global Research projecting a 62% increase in global civil adoption between 2025 and 2030.

The LAE is demonstrably expanding, underpinned by rapid technological adoption, evolving business models, and increasing policy support. Low-altitude aircraft, defined as vehicles operating below traditional aviation altitudes, include drones, eVTOL aircraft, air taxis, and hybrid or electric platforms. Their compact size, manoeuvrability, and declining costs make them well suited to a growing range of commercial applications, particularly in logistics, infrastructure inspection, and urban services. This growth is increasingly visible when examining the drone ecosystem as a leading indicator of LAE development. As of 2026, Drone Industry Insights estimates that approximately 637 companies have entered the market since 2022, illustrating both the pace of innovation and the attractiveness of the sector.

However, this expansion is already accompanied by signs of consolidation, as more mature players absorb smaller firms to scale capabilities and secure market share, evidenced by developments such as Malloy Aeronautics consolidating with BAE Systems. This dual dynamic of rapid entry and early consolidation is characteristic of industries transitioning from experimentation to commercial maturity.

At the same time, the structure of value within the industry is shifting. Services (business operations, consulting, certification) have grown from 37.6% to 42% of all companies in the ecosystem. This indicates a clear movement away from hardware-centric models toward downstream, service-led value creation. In practical terms, the growth of LAE is not only about building hardware, but about operationalising them at scale.

Even as the sector consolidates, innovation continues, with new entrants introducing differentiated solutions, for example, Aquila's development of laser-based wireless charging systems enabling drones to recharge in flight.

China is scaling fast….

China provides a leading example of how this transition is unfolding at pace and scale. Dense urban clusters and challenging terrain are generating strong demand for faster, more efficient logistics and transport solutions. Regions such as the Greater Bay Area and Guangdong are actively leveraging these conditions to pilot and deploy smart-city LAE initiatives. Rapid adoption is reshaping infrastructure and mobility, with policymakers and industry leaders increasingly viewing low-altitude airspace as an additional layer of national infrastructure, equivalent to highways or high-speed rail, capable of transforming how people and goods move between cities.

This strategic framing is reinforced by market leadership and industrial dominance. China-based DJI continues to control an estimated 70% of the global drone market as of 2024, demonstrating both technological leadership and the benefits of scale.

3. The Low Altitude Economy

London – Emerging opportunities

In parallel, high-density urban environments such as London's Canary Wharf or the City of London's financial district face significant pressure from delivery and servicing traffic, which currently accounts for around a quarter of motorised journeys, rising to approximately 32% during peak morning hours. With policy ambitions to reduce freight traffic by 50% by 2030 and 90% by 2044, low-altitude solutions, particularly drone-enabled logistics, may have a role in supporting urban freight operations for time-critical, lightweight and high-value goods. While unlikely to replace a substantial proportion of road freight, such solutions could complement existing transport networks and help address specific delivery challenges in congested urban environments.

Taken together, these LAE trends provide strong evidence in support of the central proposition that the low-altitude economy is growing. The combination of increasing market entry, early-stage consolidation, a shift toward service-led value creation, and large-scale adoption in key markets such as China signals that LAE is moving beyond experimentation into a phase of structured growth. Crucially, this growth is not only technological, but systemic reshaping infrastructure, business models, and urban mobility in ways that are likely to accelerate over the coming decade.

UK Strategic Implications:

The growth of the low-altitude economy presents a significant opportunity for the UK, with strong momentum across BVLOS operations, logistics, infrastructure inspection and urban air mobility. In the UK context, however, it remains unclear which applications will drive the market initially. Early growth may emerge from use cases where the value proposition and regulatory pathway are more established.

Solutions with dual-use applications are particularly well positioned to capture value, offering clear efficiency gains across both commercial and public-sector use cases while strengthening national resilience and operational capability. The DfT and CAA-led Future of Flight programme continues to drive development of the UK's low-altitude economy, targeting routine BVLOS operations by 2027 and commercial eVTOL passenger and cargo services by 2028.



4. Humanoid Robotics

Humanoid robots are designed to resemble and operate like humans. Unlike traditional industrial robots, they are built to function in environments designed for people, allowing them to take on roles such as elderly care, warehouse support, and public service tasks including policing.

The main attraction of humanoid robots is their ability to work in existing environments with minimal adaptation. Unlike purpose-built automated machines, they can perform a variety of tasks using infrastructure, tools and workflows that were originally designed for humans.

The United States and China currently dominate research and development in this space. Morgan Stanley estimates the market could be worth up to $5 trillion by 2050, driven by advances in AI, rising labour costs, and ageing populations, particularly in markets such as China.

Despite increasing market activity and high-profile product launches, humanoid technology remains at an early stage of maturity. According to McKinsey, while prototypes are capturing headlines and demonstrating impressive capabilities, they are still some way from delivering consistent, reliable, and economically viable performance in real-world settings.

Recent commercial developments illustrate both the ambition and the current limitations of the market. For example, US-based 1X Technologies backed by OpenAI has unveiled its Neo home robot, designed to support everyday household tasks. The product is positioned with a subscription model of $499 per month (approximately £315), or a full purchase price of $20,000 (approximately £16,000). Initial deliveries are expected to begin in the US this year, with international rollout planned after.

In China, the humanoid robotics industry is undergoing rapid development, driven by strong state direction and coordinated industrial policy. Policymakers are actively accelerating progress, with increasing emphasis on standardisation, ecosystem development, and supply chain integration.

With several suppliers now active and entry-level humanoid robots priced at around $4,000, significantly cheaper than the US-based 1X Technologies' Neo robot, China has developed a clear cost advantage. This cost advantage combined with a rapidly maturing humanoid ecosystem has enabled China to emerge as one of the fastest-moving markets in humanoid robotics.

China's Ministry of Industry and Information Technology (MIIT) reinforced this position through its 2024 roadmap, which sets out plans to establish a full-stack humanoid ecosystem by 2025. This includes advances across hardware, software, and supporting infrastructure, underpinned by a highly responsive and scalable manufacturing base. More recently, however, regulatory developments signal a parallel focus on oversight and control.

China's introduction of digital IDs for humanoid robots (designed to track systems across their lifecycle from production through to recycling) highlights a move towards tighter monitoring of deployment and associated risks.

While this could enhance traceability, safety, and accountability, it also raises broader questions around data governance, operational constraints, and the balance between innovation and regulation.

In Europe, developers are accelerating production, with companies such as Germany's Neura bringing humanoid systems to market, priced at approximately €98,000, with reservations already open ahead of a planned release in late 2026.

Europe's progress is further supported by a favourable regulatory environment. Frameworks such as the EU AI Act (2025) and the forthcoming EU Machinery Regulation (effective 2027) provide a clearer, certifiable pathway for deploying humanoid systems, particularly in regulated sectors underscoring trust and safety.

4. Humanoid Robotics

Key takeaways

- While the humanoid robotics industry is accelerating, supported by growing production and a maturing supply chain, much of the market is still very much performative at this stage. However, the implications for the labour market are becoming clearer, with increasing concern about displacement across both white- and blue-collar roles.
- In white-collar roles, the combination of humanoids with AI begins to move beyond purely physical tasks into areas involving interaction, and service delivery. While still at an early stage, this suggests a potential shift where humanoids could start to augment and in some cases replace routine roles over time. This is already the case in China.
- More immediate impacts are likely to be seen in industrial and operational environments. Building on trends already observed in aviation, where autonomous airside vehicles are being deployed at scale to handle tasks such as baggage and ground operations, these systems may demonstrate clear gains in efficiency and consistency, while reducing reliance on manual labour.
- However, the impact is not solely displacement. Demand is likely to increase in areas such as robotics integration, system oversight, and maintenance, alongside broader AI-enabled roles. The challenge will be the pace of transition, and whether workforce reskilling can keep up with technological adoption. Taken together, the trajectory points to a new dynamic: rising productivity and operational efficiency, alongside growing disruption to existing job structures.
- For the UK, the core challenge is one of pace and scale. China is advancing through coordinated industrial policy and cost advantage, while the US is driving innovation through private capital. The UK sits somewhere in between, with strong research capability but comparatively fragmented commercialisation. Without clearer direction, there is a risk the UK becomes a net adopter rather than a shaper of these technologies.
- There is also the question of strategic positioning and an opportunity to lead in setting standards for safe, trusted, and human-centric deployment, particularly in sectors like aviation where regulatory capability is already strong. However, this will require all UK regulators to act proactively, aligning approaches and adapting frameworks to a technology landscape that is evolving at pace.



5. The Effects of Structural Constraints on Aviation

Aviation's decarbonisation pathway is entering a critical delivery phase, as ambitious decarbonisation plans confront the practical challenges of scaling technologies, markets and policy mechanisms.

The aviation sector's net zero ambitions were built on the assumption that key decarbonisation technologies, supply chains and supporting policy frameworks would mature and scale rapidly. Many of these enablers, particularly sustainable aviation fuels (SAF) and greenhouse gas removals (GGRs), remain at an early stage of development, with their successful deployment reliant on progress across multiple sectors and stakeholders.

The introduction of SAF mandates and emerging government roadmaps is now testing those assumptions in practice for the first time. While progress is being made, implementation is highlighting the scale of the challenge, including limited feedstock availability, high production costs, uncertain long-term funding models and the significant coordination required across industry and government.

As a result, the gap between stated ambitions and practical delivery is becoming clearer. At the same time, attention is increasingly shifting towards GGRs as a key component of long-term decarbonisation strategies. While GGRs offer significant potential, questions remain around their scalability, affordability and deployment at the pace required, creating similar uncertainties to those currently being experienced in the SAF market.

Alongside these decarbonisation challenges, wider industry pressures are competing for the investment, capacity and coordination needed to accelerate the transition.

System constraints advanced by geopolitical tensions continue to shape operations by reducing throughput, limiting airport capacity and driving network adjustments such as rerouting and reduced schedules. For example, capacity constraints at Heathrow have periodically required passenger caps and operational restrictions, highlighting the challenges of expanding aviation activity within existing infrastructure.

Similarly, disruption to Red Sea and Middle East air corridors has forced airlines to reroute services, increasing flight times, fuel consumption and operational costs while reducing network efficiency.

Geopolitical disruption compounds these pressures by removing key hubs and constraining passenger and cargo capacity. Recent geopolitical uncertainty has also reinforced the strategic value of developing domestic capability in critical decarbonisation sectors.

Expanding UK-based SAF production and GGR capacity could strengthen energy security, improve resilience to global supply chain disruptions and provide greater confidence in the long-term delivery of aviation's net zero ambitions.

5. The Effects of Structural Constraints on Aviation

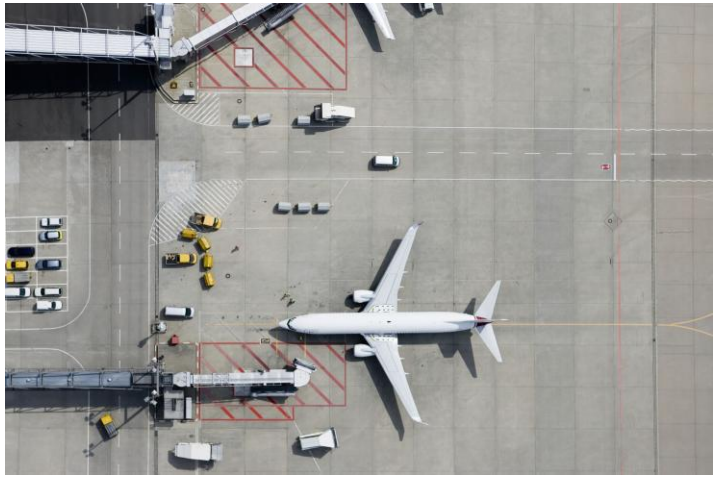
Opportunities

- Refocus transition plans around realistic deployment pathways and delivery milestones.
- Strengthen collaboration between industry and government to scale SAF and GGR markets.
- Diversify energy solutions to reduce reliance on a single market.
- Use current policy implementation to identify and address barriers before larger-scale deployment is required.
- Leverage insights from other industries to better understand future needs and opportunities.

Risks

- Reliance on international fuel, technology and carbon removal markets may expose decarbonisation pathways to geopolitical and supply-chain disruptions.
- GGRs may face similar scaling, affordability and policy challenges as SAF.
- Geopolitical disruption and infrastructure constraints increase costs and reduce network efficiency.
- Delivery of net zero targets may diverge from stated ambitions if deployment rates fail to accelerate.
- Competitive imbalance as airlines with better access to fuel, airspace, or hubs gain advantage.
- Risk of uneven market conditions and consolidation pressures.
- Fragile global network and removal of key hubs.
- Potential dependence on marginal gains rather than scalable decarbonisation.





6. Rise in Battery Production

6.8 TWh
global battery demand by 2035, up from around 2.1 TWh today.

40%
increase in lithium-ion battery thermal runaway incidents experienced by the air cargo industry since 2021.

3-4x
Potential performance gains from lithium-air batteries.

Battery manufacturing capacity has expanded rapidly over the past decade, driven by rising consumer demand, the electrification of transport, and increasing investment in low-carbon energy systems. Despite growing global investment, battery production remains heavily concentrated in Asia, which accounts for an estimated three-quarters of advanced battery manufacturing capacity.

China dominates global battery cell production, supported by a highly integrated ecosystem of raw material processors, component suppliers, equipment manufacturers, and cell producers. This scale and systemic integration have created significant cost advantages and enabled rapid production growth. South Korea and Japan also play critical roles within the global battery value chain, leveraging established industrial capabilities and long-standing relationships with major automotive manufacturers.

In response to energy security concerns and growing demand for electric vehicles and energy storage systems, Europe and North America have announced substantial investments in domestic battery manufacturing. However, both regions continue to operate from a relatively small base and face their own challenges related to supply chain development, cost competitiveness, and production scale compared with established Asian markets.

Looking ahead, battery demand is expected to accelerate further as decarbonisation efforts intensify across transport networks. McKinsey estimates that global battery demand could more than double to approximately 4.2 terawatt-hours (TWh) by 2030, rising to around 6.8 TWh by 2035. Growth is expected to be driven primarily by electric vehicles, alongside expanding deployment of grid-scale energy storage and other clean energy applications.

6. Rise in Battery Production

While lithium-ion technology is expected to remain the dominant battery chemistry in the near term, research and development activity is accelerating innovation across a range of next-generation battery technologies. Among the most promising is lithium-air technology, which offers significantly higher theoretical energy density than conventional lithium-ion batteries.

Although lithium-air batteries remain at an early stage of development, momentum is building across both industry and academia. Organisations such as PolyPlus and Air Energy are advancing commercial applications, while research institutions and government-funded programmes continue to drive technological progress. If challenges relating to durability, efficiency, and rechargeability can be overcome, lithium-air batteries could unlock substantial performance gains across electric mobility, aerospace, drone technologies, and long-duration energy storage.

Recent developments highlight growing interest in this technology within the aviation sector. Air Energy, a US-based start-up, has secured funding to scale a solid-state lithium-air battery chemistry it claims could improve drone performance by up to four times and support the development of larger regional electric aircraft. Its partnership with the Illinois Institute of Technology, under a US Department of Energy research programme, reflects increasing public and private sector investment in next-generation energy storage solutions. While forecasts remain uncertain given the technology's early stage of commercialisation, analysts estimate that the global lithium-air battery market could reach between USD 20.8 billion and USD 27.5 billion by 2030, depending on the pace of technological advancement and adoption across mobility, aerospace, and energy storage applications.

Nonetheless, batteries have become integral to modern life, driven by growing consumer demand, the rise of electric vehicles, and an expanding supplier ecosystem. However, their widespread adoption has also increased exposure to risks associated with product quality, transportation, and supply chain oversight. According to a 2026 report by UL Standards & Engagement, the air cargo industry has experienced a 40% increase in lithium-ion battery thermal runaway incidents since 2021. Battery quality and shipper behaviour were identified as the primary drivers of risk, with smaller and less experienced shippers often lacking expertise in hazardous materials handling and labelling requirements.

Geography also remains an important predictor of risk. Variations in manufacturing standards, quality assurance processes, regulatory oversight, and enforcement can influence the safety profile of batteries entering global supply chains. As battery demand continues to rise, maintaining product quality, traceability, and regulatory compliance across increasingly complex international supply networks will become a growing challenge for manufacturers, logistics providers, and regulators alike.

Taken together, these signals point to a structural shift in aviation risk. Demand for lithium batteries is growing rapidly across global supply chains, increasing the volume of batteries moving through air transport networks. As this growth continues, pressure is mounting on dangerous goods regulation, compliance systems, enforcement capabilities, and industry awareness to keep pace with evolving risks.

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