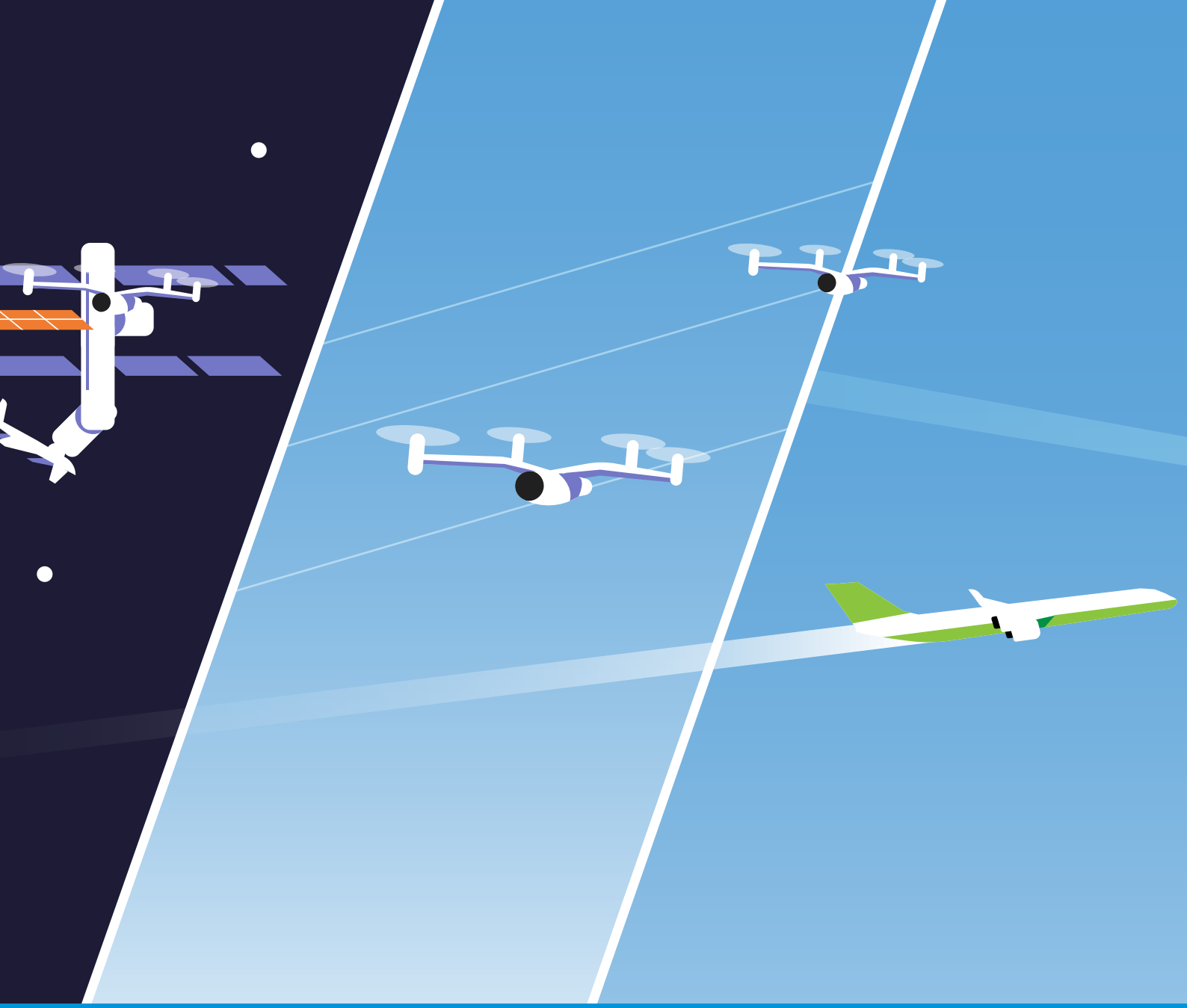
Complete Air Traffic System (CATS) Global Council

Collaborating on our Future Skies

VISION AND ROADMAP **2022**

Members of the Complete Air Traffic System (CATS) Global Council



Contents

Introduction to the CATS Global Council

The next few decades will see a significant transformation of the aviation industry. An increased demand from traditional passengers, new vehicle types delivering new service offerings, increased activity in upper and lower airspace, the unprecedented acceleration of technologies and digitisation and a global drive for sustainability are among the many factors forcing air transport to reinvent itself.

In early 2021 CANSO convened a number of senior industry leaders to form the Complete Air Traffic System (CATS) Global Council to facilitate collaboration among leaders from across the aviation and aerospace industries to build consensus on the future air transport system we need and to develop a roadmap to deliver it.

The CATS Global Council was established to drive the next era of aviation and forge a more adaptable, resilient and sustainable industry. It works under the strong belief that as a sector we need to act collectively and with a sense of urgency in order to tackle the enormous changes facing aviation and to foster the collaboration needed to incorporate new technologies and new ways of thinking.

Industry Consensus on a Future Sky Vision

In October 2021 the CATS Global Council delivered its first task – a consensus vision of what our future skies will look like in 2045. The CATS Global Council 2045 Vision imagines global airspace that is safe, fair, intelligent and interoperable, leveraging revolutionised design, technology and services to power sustainable global mobility and prosperity.

Achieving this will require:

- A harmonised, integrated and highly automated airspace
- Advances in hybrid technology, cleaner fuels, electrification, carbon capture and flight path optimisation
- The prioritisation of digitisation and technological advancement
- A common regulatory framework, underpinned by global safety standards, including at stratosphere and space levels, and
- An approach to aviation talent that embraces diversity and attracts and engages advanced skills.

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

The operating principles are:

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

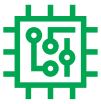
Interoperability: The cooperation and interconnectedness of diverse operators is essential for a fully integrated, harmonised sky.

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

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

The CATS future skies vision is built on seven building blocks that are essential to success and global progress. The seven building blocks are:

Services and Service Delivery



Technology and Digitisation

Safety and Regulation

Environmental Sustainability and Social Impact

Airspace Design and Classification

Data and Security

People, Organisation and Talent

CATS Global Council members recognise that advancements in technology and digitisation will enable higher levels of automation in 2045 and fuel the rise of new and improved user-centric services. The air traffic management services needed to serve our future skies will be more dynamic, agile, adaptable and yet consistent. The aim is to significantly enhance the overall performance of trajectory management, including such aspects as safety, capacity, efficiency, resilience, cost effectiveness, environment, flexibility, predictability and security.

A key development is the abstraction of services and applications from the underlying hardware. New technology will then easily integrate into the air navigation system using a simplified modular approach and a multi-cloud platform. This has enormous consequences across several performance areas, especially capacity.

The current roles of people in the system will evolve as some tasks are automated and new skills will be required, supported by a diverse workforce and agile training programmes. Airspace will itself evolve to become truly seamless, scalable, sustainable, resilient and demand-driven. All airspace users will have their preferred trajectory whenever possible.

Traditional customers in the skies – airlines – will be utilising aircraft with fully connected cockpits enabling large amounts of data to be transferred in real time, transforming service capabilities through initiatives such as system-wide information management (SWIM).

And new customers will come to the fore, such as drones and other urban mobility vehicles. These will bring their own requirements and performance parameters.

The organisation and management of airspace will need to be harmonised, cost-effective, interoperable, data-centric, secure, optimised, sustainable, demand-driven, performance-based and should promote competition, unlocking new business models and revenue streams that generate value for all stakeholders. This will contribute greatly to system resilience and scalability.

If we are to meet future needs, airspace must be transformed into a unified environment that integrates a diverse mix of airborne vehicles, equipment and services in an operationally flexible, dynamic and cross border way while enabling States to retain legal, security, administrative and judicial powers within their national airspace.

Intermodality will be crucial. Advanced interconnected transport networks will allow air transport to deliver clean, seamless door-to-door experiences for passengers. But enhancing global mobility, public convenience and meeting the needs of economies will be insufficient to our future success. We must embrace sustainability, not just in our approach to reducing carbon emissions, but in all respects and across the entire system as we seek to operate in respect for the planet and the communities we serve.

Safety will remain aviation's top priority in the future. As we move towards higher levels of automation, it will be essential to ensure services are designed to maximise their contribution to delivering safe operations and the industry's strong culture of safety must be extended to those involved in software and technology design. Safety service performance will be based on a predictive approach to risk using advanced insight into total system performance (normal and abnormal) gathered by advanced data analytics in real or near-real time.

In order to foster a global culture of innovation, we must look for ways to balance strong safety leadership with speed of innovation by re-examining our regulatory and certification processes.

The adoption of technology must be done in a way that amplifies the combined strengths of humans and machines, enabling people and technology to interact seamlessly together as high performing teams. This will require thoughtful research and careful management and it is a transition that is likely to occur in phases.

The CATS Global Council is committed to leading the dialogue and work necessary to ensure that technology developments proceed in a logical and safe way and that the airspace management community thrives with a new generation of highly-skilled talent and is seen as an appealing sector in which to work. Aviation industry competency models will have to be updated to deliver performance-based training programmes, providing opportunities for continuous monitoring and evaluation and reflect new diverse roles and skills critical to operation within high-capacity and advanced technologies environments.

Read the CATS Global Council Vision at **futureskyvision.com**

A roadmap to deliver the skies of 2045

The CATS Global Council has developed and launched a roadmap which outlines the long term goals, intermediate milestones and actions that will need to be achieved in the years between now and 2045 to keep aviation on a path towards the future we have set for ourselves. Critical enablers and evolutionary steps have been identified in ambitious but achievable timelines.

The roadmap is a living document for which industry holds itself accountable for progress, along with direct engagement with ICAO, States, standards organisations and regional and national regulators. The roadmap will be used to galvanise the industry and to enlist and engage stakeholders in the CATS vision for future skies and the necessary activities to get there.

Fourteen long term goals have been identified which relate to all of the seven building blocks of the CATS Global Council vision.

For each long-term goal, the roadmap identifies the key milestones and actions that need to occur to achieve it. Over 70 milestones and 100 actions have been identified.

The milestones and actions in the CATS Global Council Vision Roadmap are included in Annex B or are available as an interactive format here.

The roadmap is a concrete example of the power of cross-industry leadership that the Global Council has generated. There is a great deal of work to be done, but with the completion of the roadmap, our pathway to the vision for the skies of 2045 has become clearer.

CATS 2045 Vision Long Term Goals

1	Improved performance through automation
2	Harmonised service delivery
3	Integrated airspace
4	Harmonised, efficient and flexible systems
5	Digital Collaboration
6	Safety and Security by design
7	Predictive approach to risk management
8	Strong safety and quality culture
9	Towards reduced climate impact
10	Environmental sustainability and social impact management are broadly integrated into the air transport system
11	Integrated and connected multimodal transportation network and infrastructures
12	Data-powered ecosystem
13	Thriving airspace management community
14	High performing teams

CATS Global Council Roadmap

CATS Global Council – Long Term Goals

	Title	Long term Goal (2045)	Linked Milestones
G1	**Improved performance through automation**	Advancements in technology and digitisation have enabled higher levels of automation and fuelled the rise of new and improved user-centric services. This change in paradigm is "serving" existing needs and allowing us to solve an ever-growing and diverse user demand and: ▪ The overall performance of Trajectory Management is significantly enhanced (Safety, Capacity, Efficiency, Resilience, Cost Effectiveness, Environment, Flexibility, Predictability, Security). For example, through Flight and Flow information supporting all phases of flight. ▪ A Total performance system is implemented that includes safety, efficiency, resilience, etc. ▪ The tactical intervention model has evolved into a more strategic trajectory management concept and operations are highly automated, or autonomous and distributed ▪ The task between human system partnership is optimised (e.g. automation of some tasks, and new roles to manage the human-system partnership) ▪ Safety is demonstrated with predictive de-risking and there is global public acceptance that emergent technology does not negatively impact societies and communities	M1, M4, M9, M17, M17, M18, M25, M31, M34, M50, M68, M72
G2	**Harmonised service delivery**	The design and delivery of services are: ▪ Harmonised, dynamic, flexible, resilient and scalable to meet the future needs of all airspace users ▪ Decoupled/outsourced from underlying physical hardware enabling services to be seamlessly delivered from different geographical locations. ▪ Ensure fairness amongst the different stakeholders ▪ Increasingly managed regionally and collaboratively (e.g. ATFM) by data service providers	M1, M2, M3, M4, M13, M25, M50, M52, M54, M60, M72
G3	**Integrated airspace**	Airspace becomes a unified environment that seamlessly integrates a diverse mix of airborne vehicles (piloted and unpiloted), equipment and services. States retain legal security administrative and judicial powers within their national airspace in an environment in which service has evolved to be operationally flexible, dynamic and seamlessly cross border. Seamless and comprehensive airspace has been established through civil, military, and service provider agreements, i.e. Flexible Use of Airspace (FUA); Space-destined traffic, supersonic aircraft and ultra-long-haul flights are supported by airspace that enables the provision of service without conflicting and disrupting the daily operations of all other airborne vehicles.	M1, M2, M3, M4, M5, M6, M7, M8, M18, M27, M39, M41, M42, M43, M44, M45, M47, M48, M67, M69

CATS Global Council – Long Term Goals

	Title	Long term Goal (2045)	Linked Milestones
G4	**Harmonised, efficient and flexible systems**	Implementation of harmonised, efficient and flexible systems is based on a technology platform which: ▪ Is based on latest technology practices and paradigms. The abstraction of services and application from the underlying hardware allows new technology to quickly integrate into the Air Navigation System ▪ Allows simplification and modularisation of systems ▪ Enables the standardised use of commercial off-the-shelf (COTS) equipment ▪ Allows for the fast integration of new aeronautical systems and technologies with different operating characteristics ▪ Enables cyber security and cyber resilience integrated into platform design from the beginning, whilst ensuring inherent resilience against cyber-related threats and vulnerabilities	M9, M10, M16, M17, M26, M54, M70
G5	**Digital Collaboration**	An open approach to digital development has been implemented giving people access to the right data to perform their role and increasing collaboration and avoiding duplication, maximising resources — and ultimately increasing their impact — through open standards, open data and open innovation.	M12, M14, M15, M16, M18
G6	**Safety and Security by design**	Trajectory Management (TM) services are designed to maximise their contribution to delivering safe operations in the air and on the ground for all airspace users and in all circumstances (e.g. nominal and non-nominal situations). The design of the services is optimised to handle variability within the system and taking into account the complete value chain(s), managing the complexity of multiple stakeholders / contributors to create and maintain a safe aviation ecosystem.	M16, M19, M20, M21, M24, M51, M54
G7	**Predictive approach to risk management**	Trajectory Management (TM) service performance is based on a predictive approach to risk management, using advanced insight into total system performance (normal and abnormal) gathered by advanced data analytics in real or near-real time and leveraging open data sharing amongst all stakeholders.	M22, M23, M27
G8	**Strong safety and quality culture**	Culture principles have been embedded which facilitate open reporting and safety learning. The organisation aspires to have a culture where staff at all levels are empowered, and have the means, to contribute meaningfully to the management of safety within the organisation. A Just Culture is recognised as being critical to achieving this; and helping to effectively managing safety risk and achieving the highest levels of safety performance. The industry's strong culture of safety has extended to those involved in software and technology design.	M24, M51, M58
G9	**Towards reduced climate impact**	The sky of 2045 is cleaner and more efficient. Even though our skies are busier than ever before the aviation sector continues to limit its impact on the environment. The aviation industry is tracking towards net zero through in-sector and out of sector measures, including carbon capture and storage.	M1, M3, M28, M29, M30, M31,M32, M33, M34, M36, M37, M38, M41, M43
G10	**Environmental sustainability and social impact management are broadly integrated into the air transport system**	Environmental sustainability and the management of social impact are integrated broadly into the air transport system including operations, infrastructure and life-cycle considerations. The aviation industry is living in harmony with the communities it serves.	M31, M32, M35

CATS Global Council – Long Term Goals

	Title	Long term Goal (2045)	Linked Milestones
G11	**Integrated and connected multimodal transportation network and infrastructures**	Airspace design enables expanded accessibility to airspace for all novel aircraft and transport usage including multi-modal transportation systems (e.g. AAM) and infrastructures (e.g. vertiports) through digitalisation, automation, and the adoption of data services. Multimodal transport interfaces have been widely implemented. Connected architectures enable seamless completion of journeys that transition between types of transport.	M27, M32, M34, M35, M39, M40, M41, M46, M47, M48
G12	**Data-powered ecosystem**	Airspace is supported by an intelligent globally distributed data-powered ecosystem with millions of nodes based in the air and on the ground: ▪ In this intelligent, globally distributed, data-powered ecosystem, each operator participates in a safe, secure, open, and scalable framework for exchanging interoperable information. ▪ A globally distributed data network enables secure flows of high-volume information and robust data exchange between trusted users, infrastructure (e.g. vertiports) and air vehicles. ▪ As aircraft and ground-based capabilities continue to digitise and modernise, the airspace system has grown enabling broader integration, harmonisation and interoperability of all users. ▪ Open information exchange facilitates operational excellence, decision-making and risk management ▪ Aircraft are increasingly becoming web-connected devices and part of the broader Internet of Things (IoT), especially in urban environments with multi-modal transport infrastructure.	M3, M6, M10, M11, M14, M15, M16, M49, M50, M51, M53, M54, M64, M65, M67, M71
G13	**Thriving airspace management community**	The airspace management community is thriving with a diverse, high-skilled talent base focused on value delivery and attracting talent to collaborate in a hybrid digital and people workplace: ▪ The skills profile of employees in the sector reflects diverse roles and skills critical to the operation of advanced technologies, complex data-sets and within high-capacity environments. ▪ Learning and development in the sector are a priority with continuous learning mechanisms and evolved models of competency. ▪ Diversity and inclusion are integral to our culture and enable increased innovation and agility.	M55, M56, M57, M58, M59, M60, M61, M62, M63
G14	**High performing teams**	The adoption of technology continues to amplify the combined strengths of humans and machines. People and technology interact seamlessly together as high performing teams.	M1, M59, M63, M66

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M1	**New CONOPS**	Innovative new high-level Harmonised Concept of Operations (CONOPS) designed for the next era of traffic management, supported by: ▪ Operational services environment description (OSED) ▪ Value proposition for the new services ▪ ATM-UTM integration roadmap, including a CONOPS for mixed mode ATM and UTM so it is just TM, agreed by all stakeholders, to plot a course toward full convergence	G1, G2, G3, G9, G14	A1, A2, A3, A5, A10, A11, A13, A39, A41, A97, A99, A100	2025
M2	**Cross border service delivery**	Interoperability and use of common standards is ensured – enabling regularised cross border service delivery arrangements and more flexible business continuity planning	G2, G3	A20	2030
M3	**International collaborative ATFCM process**	An internationally integrated and collaborative airspace management concept established with a dynamic air traffic flow and capacity management, in response to traffic demands	G2, G3, G9, G12	A27	2025
M4	**Conceptual framework for decentralised management of airspace across borders**	New framework developed enabling the de-centralised management of airspace across borders, addressing liability, security, defence, regulatory, political and financial aspects by States	G1, G2, G3	A6	2025 – 2030
M5	**UAS deconfliction strategy & cooperative avoidance provision**	On aircraft coordinated deconfliction strategy and sense and avoid technologies have been implemented for lower altitude new entrants/ UAS	G3	A78	2035
M6	**Harmonised FUA**	Flexible use of airspace/Advanced-FUA techniques globally implemented in harmonised way	G3, G12	A67	2025
M7	**Integrated and harmonised high altitude**	High altitude airspace fully integrated and harmonised	G3	A78	2035
M8	**Integrated and harmonised AAM**	Advance Air Mobility (AAM) airspace fully integrated and harmonised	G3	A89	
M10	**Open architecture**	Open Architecture widely implemented through the adoption of Service-Oriented Architecture (SOA) to defragment the overall TM system and facilitate the insertion/removal of TM modules	G4, G12	A18, A20	2035
M11	**Global electronic conspicuity**	An independently validated global electronic conspicuity standards guidance implemented for all participants aimed at air to air and air to ground conspicuity	G12	A42	2025
M12	**Culture of innovation**	A culture of innovation has been globally fostered and adopted within the industry, and is supported by adequate changes in the regulatory system, in order to swiftly and safely integrate emerging technology paradigms when they are sufficiently mature and add value or solve business issues.	G5	A14, A89	2025
M13	**Performance-based CNS**	Performance based CNS allows use of all paths that meet the required performance and provide maximum resiliency	G2		2030

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M14	**Trusted entities**	Digital mechanisms implemented to rapidly, and securely, certify trusted (data) service providers using harmonised standards and their integrity.	G5, G12		2030
M15	**Authoritative data**	A high-degree of fidelity and accuracy in authoritative data sources implemented	G5, G12	A80, A85	2025
M16	**Use of open standards**	Open standards for data exchange (such as pre-flight and live flight tactical data) are widely used.	G4, G5, G6, G12	A17, A66	2025
M17	**Autonomous decentralised operations**	Autonomous services progressively expanded beyond human operators (e.g. pilots) and support a machine-to-machine interface with no human interaction (e.g. in lower altitude UAS operations) supported by increased data sharing.	G1, G4		2035
M18	**Network of sandboxes**	Evolving Eco-systems modelling & simulation tools and sandboxes connected to test, trial, share results and demonstrate new forms of service provision and to shorten the innovation cycle and visualise / measure progress	G1, G3, G5	A44, A77	2025
M19	**SMS objectives supporting airspace user goals**	Management safety system objectives for service providers designed to meet outcomes for airspace users	G6	A21, A22, A23	2035
M20	**Total Aviation System Risk Picture**	Total Aviation System Risk Picture developed and ATM services defined enabling airspace users to manage safety risks in all circumstances (i.e. nominals and non-nominal situations).	G6	A24, A24	2030
M21	**Assure ATM service in design, implementation and in-service**	Methods to assure ATM service in design, implementation and in-service defined for service providers and regulatory authorities.	G6	A26, A28, A29	2030
M22	**Global policy for proactive risk management**	Global policy for proactive risk management for strategic and tactical service delivery, consistent across all business risks and applied across the industry is agreed to be established.	G7	A31, A32,A33, A34	2030
M23	**Real time service monitoring**	ATM Services monitored in real and near-real time to ensure adherence to service delivery targets to optimise airspace user capabilities	G7	A35	2035
M24	**Global safety culture principles**	Principles for culture globally agreed upon and published	G6, G8	A36, A37, A38	2025
M25	**Agile regulatory practices**	International regulatory framework established based on a set of principles that serve the performance needs of all airspace users and adaptable to regional and state needs. The framework includes definition of new services, and the roles and responsibilities necessary to enable the safe integration of new airspace users: ▪ ICAO/States/other regulators acted with agility to speed up the development of SARPs ▪ ICAO revised its work programme to better match the innovation cycle and support the safe implementation of new technologies.	G1, G2	A4, A19, A30, A43, A74	2030

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M26	**Clear standards development path and outcome**	Fundamental outcomes for each standard and path for development agreed upon. All stakeholders commit on standard implementation.	G4	A17, A45, A46, A47, A48	2030
M27	**New approach to surveillance services and Detect and Avoid for all traffic**	New approach to surveillance services introduced based on performance requirements for surveillance to aid Detect and Avoid (DAA), which might be different than those for separation services (lower power transponders, diverging technologies etc).	G3, G7, G11		2030
M28	**Agreed sustainability goals**	ICAO approval of a long term aspirational sustainability goal for aviation secured at ICAO Assembly 41, generating increased state engagement and new policy measures in support of SAF production, infrastructure and R&D investment	G9	A49, A56, A58	2022
M29	**Harmonised decarbonisation roadmaps**	ATM improvements in decarbonisation roadmaps embedded in all ANSPs' strategic plans and investment is prioritised accordingly.	G9	A50, A57, A71	2025
M30	**Impact of contrails**	Developed a full understanding of the climate impact of contrails so that we are able to predict where and when they will form and put in place tools to mitigate them	G9	A51, A63, A64	2025
M31	**Global sustainable procedures**	Clear harmonised global procedures created to ensure the full integration of new airborne technologies is achieved without emissions / noise unintended consequences	G1 , G9, G10	A15	2030
M32	**Aerodrome/vertiports infrastructure**	Guidelines developed to ensure new aerodrome/ vertiports infrastructure is sustainably designed, constructed and operated	G9, G10, G11	A65	2026
M33	**Formation flying**	Formation flying approved and new ATM tools implemented that enable a material reduction in emissions for participating aircraft	G9	A55, A60, A62	2030
M34	**Electric UAS and eVTOLs reduced emissions in urban areas.**	Electric UAS and mobility services such as drone-based last-mile deliveries and air taxis replaced a substantial number of road vehicle logistics reducing emissions in urban areas.	G1, G9, G11	A53	2030
M35	**Multi-modal transport**	The efficiency of multi-modal transport is a public policy priority	G10, G11		2035
M36	**Low carbon and zero carbon energy sources**	Significant investment in research and development and production scale up, and increased access to low carbon and zero carbon energy sources	G9		2035
M37	**Reduction of UFP emissions**	A meaningful reduction in ultrafine particles (UFPs) emissions achieved through operational procedures and engine technology advancements	G9	A69, A70	2035
M38	**Infrastructure support for green technologies**	Infrastructure introduced that supports sustainable aviation fuels and electric powered vehicles and aircraft	G9		2035
M39	**UAM operations are increasing**	UAM operations increased in a growing number of cities with some operations from airports.	G11	A8, A87	2025

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M40	**Broad implementation of UAM**	Broad implementation of UAM, with new ground infrastructure and integration in the airspace.	G11	A8, A53, A54, A59, A68	2035
M41	**Simplified airspace design**	Simplified airspace designs harmonised between States, supported by regulatory and environmental initiatives, including cross border where appropriate, supporting the integration of all airspace users	G3, G9, G11	A72, A75, A81	2035
M42	**Integrated and collaborative information systems**	Airspace managed through integrated and collaborative information systems providing a common situational awareness.	G3	A76	2030
M43	**Harmonised and optimised airspace**	Widespread implementation of harmonised and optimised airspace including more flexible, efficient and customer-oriented structures that increase airspace capacity enabling users to fly as close as possible to their preferred optimal trajectory.	G3, G9	A72, A75, A76	2030
M44	**Harmonised upper airspace**	Upper airspace (stratospheric) boundaries defined and globally harmonised.	G3	A73	2030
M45	**Civil-military collaboration**	Flexible Use of Airspace (FUA) and automated FUA processes implemented that improve automated data exchanges and collaboration between civil and military stakeholders	G3, G12	A67	2025
M46	**Network based, on-demand synchronisation of trajectories**	Airspace designed to support the implementation of network based, on-demand synchronisation of trajectory-based operations	G11		2030
M47	**Airspace design supports dynamic airspace and user integration of all users**	Airspace designed supporting the broad implementation of dynamic airspace to enable airspace usage by all players, and the integration of all participants in a more efficient way, based on their capability, common rules, and performance-based requirements	G3, G11	A8, A87	2030
M48	**Airspace design supported by common rules**	Airspace design supported by clear sets of common rules/regulations and performance-based requirements for accessing various airspace operating environments	G3		2030
M49	**Aviation trust**	Widespread agreement on a mature international aviation trust framework	G12	A79, A85	2025
M50	**Digitally connected aviation**	Broad implementation of the international aviation trust framework enables global and digitally connected aviation. A global consensus on data security standards achieved and there is broad use of data standardisation and exchange models to enable multi-modal information exchanges, collaborative decision making, increased automation and future services.	G1, G2, G12	A66, A83	2035
M51	**Security culture**	Security culture improvements widely implemented to increase security sensitivity among Information Technology (IT) and aviation professionals.	G6, G8, G12		2025

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M52	**Secured communications**	Secured and performance-based communications support all interchanges, eliminating the 100% reliance on aviation spectrum	G2, G12	A84	2035
M53	**Cybersecurity training**	Global guidance for cybersecurity training programme to increase competencies among all front-line actors	G12		2025
M54	**Cyber security and resilience**	Cyber security and cyber resilience are system-wide priorities, with global quality standards that every user must comply to. ▪ The global, interoperable framework allows for trusted ground-air, air-air and ground-ground exchanges for digital identity and user authentication. Strict privacy policies introduced that respect sovereignty and protect user privacy. ▪ States, regulators and organisations continue to collaborate on all matters relating to cyber security and cyber resilience to protect our global skies. ▪ IT Security Management Systems implemented by all aviation stakeholders and an exchange of possible threads being detected in the aviation network shared among all users immediately	G2, G4, G6, G12		2025
M55	**New competency model**	Aviation industry competency model updated using objective data to deliver performance-based training programmes, and provide opportunities for continuous monitoring and evaluation.	G13	A90	2025
M56	**Holistic review of the skills needed in future aviation system**	A holistic review of the skills needed in future aviation systems assess the skills gaps and provides a range of rewarding career paths that are attractive to the next generation of talent	G13	A88, A96	2025
M57	**Learning experience is immersive and digital**	An immersive and digital learning experience created where people learn in the flow of work, leading to the flexible provision of training, scaled to the needs of an organisation. Flexible delivery on training using digital learning where appropriate	G13	A95, A93	2030
M58	**Harmonised change management**	Change management best practices embedded in organisations and harmonised change management training is broadly deployed.	G8, G13	A61, A92, A98	2025
M59	**Open and collaborative social dialogue**	Employee relations evolved promoting open and collaborative social dialogue and a modern joint problem-solving approach by all parties.	G13, G14	A91	2025
M60	**Flexible deployment of resources**	Controller training improved and changes in licensing provide added flexibility in the deployment of resources that enhances scalability.	G2, G13		2030
M61	**Diversity and Inclusion campaigns**	Diversity and Inclusion awareness campaigns ensured that measures are broadly implemented challenging norms in the industry and evolving the industry's workforce	G13	A93, A94	2025

CATS Global Council – Milestones

	Title	Milestones	Goals	Actions	When
M62	**Diversity and Inclusion targets**	Diversity and Inclusion targets met, generating new opportunities for improved decision making and a broader consideration of business impacts	G13		2035
M63	**Adapted contingency provisions**	Adapted contingency provisions ensured that the situational awareness and skill required for take-over is maintained through a blend of operational experience, in which the individual is actively engaged in decision-making, and multimedia training.	G13, G14	A11, A82, A99	2030
M64	**More efficient use of spectrum**	New standardised technologies have been implemented for craft to operate using a more efficient use of spectrum.	G12	A86	2035
M65	**Communication infrastructure**	A global communication network (or combination of...) is implemented and able to cope with the security, latency, bandwidth and number of users expected.	G12		2035
M66	**Automation strategy**	A strategy to enhance automation functions that fosters trust and confidence has been widely developed and agreed	G14	A11	2025
M67	**New data requirements for integration of new entrants**	New data requirements for integration of new entrants are defined. For example, data associated with eVTOL pads may need to be collected and published in an AIP	G3, G12		2025
M68	**New ANS financing mechanisms**	New cost-recovery mechanisms have been implemented that adequately and fairly cover the costs associated with the provision of services to an expanded customer base and provide sufficient performance incentives.	G1	A13	2025
M69	**Harmonised control traffic regions and terminal areas**	Integration of UAM operations and other new entrants into control traffic regions and terminal areas defined and harmonised globally	G3	A8, A59, A77, A87	2030
M70	**Global standardisation strategy**	A global standardisation strategy clearly defines the standards that are needed and how to use them.	G4		2035
M71	**Civil-military interoperability is ensured**	Civil-military interoperability and coordination is ensured through the evolution to a single system with different user levels	G12		2035
M72	**Disruption management**	An enhanced disruption management plan is implemented to respond to all type of disruptive events in real time (e.g. weather, volcanic ashes, GNSS disruptions, etc)	G1, G2	A52	2030

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A1	**Develop a New CONOPS**	Develop a new high-level Harmonised Concept of Operations (CONOPS) for all airspace users to drive the next era of air traffic management (capturing this CATS Roadmap), including ▪ Higher Airspace Operations and Lower airspace operations Advanced Air mobility ▪ Operational services environment description (OSED) ▪ Value proposition for the new services	M1	2025
A2	**Learn from ICAO vision for 2025**	CANSO to investigate which parts of the Global Air Traffic Management Operational Concept (2005), ICAO vision for 2025 and beyond, have not been achieved yet and to extract "lessons learnt" applicable to CATS roadmap	M1	2025
A3	**Integration roadmap**	Create a global ATM-UTM integration roadmap, including a CONOPS for mixed mode ATM and UTM (so it is just TM), agreed by all stakeholders, to plot a course toward full convergence ▪ Identify common technologies – for example for air-to-air conspicuity and air to ground conspicuity (surveillance) ▪ Determine what the role is that ATM / UTM will need to play in a fast changing environment where self-separation becomes increasingly possible and where direct and highly secure data communication becomes the common good for the majority of users ▪ Identification of minimum technical implementations per type of service (UAS logistics, Air Taxi, Recreational…)	M1	2025
A4	**Global Regulatory Framework**	Support the development of a global regulatory framework that includes the definition of new services, roles and responsibilities necessary to enable the safe integration of new airspace users, as described in the global CONOPS ▪ ICAO to be more agile in an effort to speed-up the development of SARPs ▪ ICAO should consider revising its work programme to better match the innovation cycle and support the safe implementation of new technologies.	M25	2030
A5	**Vision Alignment**	CATS to monitor and promote alignment between CATS vision roadmap and global/regional midterm plans	All	-
A6	**Conceptual framework for decentralised management airspace across borders**	Define and promote a new framework that enables the decentralised management of airspace across borders, addressing liability, security, regulatory, political and financial aspects	M4	2025
A7	**Regulators Understanding**	Promote and strengthen the understanding of Civil Aviation Authorities and Regulators of SARPS and National Regulations and the important influence they have on promoting or stifling innovation. Encourage a harmonised approach to managing exceptions.	M25	2030
A8	**Modelling & Simulation**	Establish a network/ecosystem of aviation modelling and simulation tools and sandboxes to test, trial, and demonstrate new forms of service provision and to shorten the innovation cycle and visualise / measure progress, including business model analysis and simulation of business cases. Definition of establishment of minimum requirements or certifications for establishing the sandbox or test environment	M18	2025
A9	**Define Flight Levels and requirements**	Define Urban and +FL 600 management requirements and develop management solutions.	M7, M8,	2035

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A10	**Conflict management**	Enhanced strategic conflict management systems and capabilities.	M1	2025
A11	**Automation strategy**	Develop an implementation strategy for enhanced automation functions that fosters trust and confidence.	M1, M63, M66	2025
A12	**Improved cooperation between NSAs**	Improved cooperation between National Supervisory Authorities (NSAs) to support the shift towards a more service-oriented environment ensuring a common interpretation and a harmonised approach.	M25	2025
A13	**New ANS financing mechanisms**	Develop new business models to address the greater diversity in aircraft operations and supporting services.	M1, M68	2025
A14	**Coordinated development**	Improved coordination for development and deployment of innovative solutions (at global and regional level)	M12	2025
A15	**Global procedures**	Create clear harmonised global procedures to ensure the full integration of new aircraft technologies is achieved without emissions / noise unintended consequences	M31	2030
A16	**Technology roadmap**	Identify new technologies and update/create a global technology roadmap to support the new Global CONOPS which is user driven and provides for regional differentiation. For example, identify Technologies: **a.** For air-to-air conspicuity and air to ground conspicuity (surveillance) **b.** That can assist in reducing human workload **c.** That enable digital sharing of critical information between participants to aid sense & avoid, collision avoidance and decision making.	M9	2025
A17	**Standardisation strategy**	Develop a standardisation strategy to better use the standards that we have – and identify what standards we need. Support the rationalisation and acceleration of the standardisation process	M16, M26	2025
A18	**Open system architecture**	Promote the implementation of Open system architecture across ATM/UTM for easy insertion/removal of ATM/UTM modules e.g. identify best practices	M10	2035
A19	**Cloud providers**	Create a global framework for certification of Cloud providers (safety-critical systems)	M25	2030
A20	**Support adoption of open architecture**	Promote and support transition to open architecture through the adoption of SOA, including regulatory aspects and oversight	M2, M10	2030
A21	**Management System Updates**	Review existing Management System Objectives (e.g. QMS and SMS) to identify implications and opportunities to improve ATM service delivery.	M19	2035
A22	**Service Innovation Standards**	Design a new management system approach using international resilience and service management standards to support an agile and innovative approach to services delivery.	M19	2035
A23	**Safety Management Standards**	Develop strategy to ensure safety management objectives (e.g. risk management, performance analysis, improvement, change) are embedded into integrated business working practices.	M19	2035
A24	**Total Risk Picture**	Create a Total Aviation Safety Risk picture including ATM services to mitigate airspace users safety risks for each iteration or evolutionary step to 2045	M20	2030

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A25	**Key Safety Functions**	Define key functions of the TM services required to deliver safe and resilient outcomes for airspace users.	M20	2030
A26	**Flexible Assurance**	Develop new flexible assurance level methods to support design of the system and ensure efficient delivery of services and without constraining innovation (i.e. standardisation of good practices across all elements of the system).	M21	2030
A27	**Collaborative airspace management concept**	Develop an internationally integrated and collaborative airspace management concept	M3	2025
A28	**System Analysis Techniques**	Develop new standards that focus on system analysis techniques to help match the capabilities of the machine and the human in the design of the ATM/UTM system, with emphasis on how the human adapts to handle variability within the system whilst ensuring no additional workload	M21	2030
A29	**Certification Approach**	Define certification and assurance approaches to accommodate distributed, service-oriented architectures that use a diverse range of service providers	M21	2030
A30	**AI Certification**	Define certification and assurance approaches for autonomous functions developed using AI capabilities.	M25	2030
A31	**Predictive Risk Management**	Principles for a predictive approach to risk management are agreed and are consistent with the performance metrics (from a leading and lagging perspective).	M22	2030
A32	**Risk Metrics Use**	Airspace Users understand the risk metrics and use the intelligence to inform their operations strategically and tactically.	M22	2030
A33	**Risk Management Trials**	Trials are undertaken to demonstrate benefits of integrated risk management.	M22	2030
A34	**Risk Management Sharing**	ATM Service providers have adopted the risk management principles and insight is shared collaboratively for the global interest.	M22	2030
A35	**Real time performance**	Advanced data analytics helps us understand real-time and near-real time performance of the total system and using digital twin concepts allows us to understand impact of changes.	M23	2035
A36	**Safety Culture Programme**	Identify purpose and scope of the safety culture principles and the stakeholders required to define a safety culture programme.	M24	2025
A37	**Culture Principles**	Develop principles for service providers that promote a culture that supports trust, learning, open reporting and sharing of information across the entire aviation industry to aid the continuous improvement of Flight Safety.	M24	2025
A38	**Safety Culture Exemplars**	Develop an exemplar programme and material to promote implementation of the safety culture principles.	M24	2025
A39	**Use Cases**	Define a set of airspace scenarios and for each scenario describe the level of performance (minimum level) required for each airspace user and supporting service providers.	M1,M9	2025
A40	**Minimum ATM Services**	Define a set of common ATM services that are required to deliver the minimum performance levels in the most effective way.	M1	2025
A41	**Gap Analysis**	Conduct a gap analysis between current ATM and AIM data and service requirements and future ATM and AIM data and service requirements for the airspace in 2045; capturing best practice where possible.	M1	2025

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A42	**Global electronic conspicuity standards**	Develop an independently validated global electronic conspicuity standards guide	M11	2025
A43	**Identify key regulatory changes**	Identify the key changes to the regulatory environment and existing regulatory instruments required to achieve the new principles of the regulatory framework.	M25	2030
A44	**Regulatory Sandbox**	Identify 'sandbox' opportunities to trial / further develop principles of the regulatory framework in collaboration between regulators and industry.	M18	2025
A45	**Standardisation Topics**	Identify the topics (e.g. tech, information, software etc.) that require standardisation (using scenario planning to help explore the topics).	M26	2030
A46	**Standardisation Stakeholders**	Identify the industry bodies and expertise required to support development of standards for each topic	M26	2030
A47	**Standardisation Attributes**	Develop key attributes for each standardisation topic that must be incorporated into the standards (including the scenarios that they support)	M26	2030
A48	**Standardisation Owners**	Agree responsibility for the development of standards for each topic i.e. which standards body(ies) is most appropriate.	M26	2025
A49	**ICAO Goal**	Secure ICAO approval of an ambitious long term aspirational goal for aviation carbon emissions at ICAO Assembly 41, which would generate increased state engagement and new policy measures in support of SAF production, infrastructure and R&D investment	M28	2022
A50	**Operational Measures**	ATM improvements in the decarbonisation roadmaps are embedded in all ANSPs' strategic plans and investment has been identified and secured	M29	2025
A51	**Contrail Research**	Undertake research in order to fully understand the climate impact of contrails and be able to predict where and when they will form and start to put in place tools to mitigate them	M30	2025
A52	**Implement an enhanced disruption management plan**	Develop and implement an enhanced disruption management plan to respond to all type of disruptive events in real time (e.g. weather, volcanic ashes, GNSS disruptions, etc)	M72	2030
A53	**Lower Airspace Community Engagement**	Undertake community engagement to proactively address public concerns (privacy, noise, safety) and improve perception of increased activity in lower airspace.	M34, M40	2030
A54	**Community Engagement Good Practice**	Develop best practice guidance on community engagement for new type of aircraft operations	M40	2030
A55	**Formation Flying**	Publication of provision for Formation flying and implementation with new ATM tools that enable a material reduction in emissions for participating aircraft	M33	2030
A56	**Environmental KPIs**	Develop improved environmental KPIs for ATM and generate consensus around their use	M28	2025
A57	**Environmental standards Advocacy**	Promote and encourage ANSP and airport participation in accreditation programmes that drive environmental action, ambition and accountability.	M29	2025
A58	**LTAG Measures**	Implement the means to track the industry's progress towards its long-term global aspirational goal for international aviation (LTAG) and report regularly, adjusting plans as necessary.	M28	2025

CATS Global Council Vision – Identified Actions

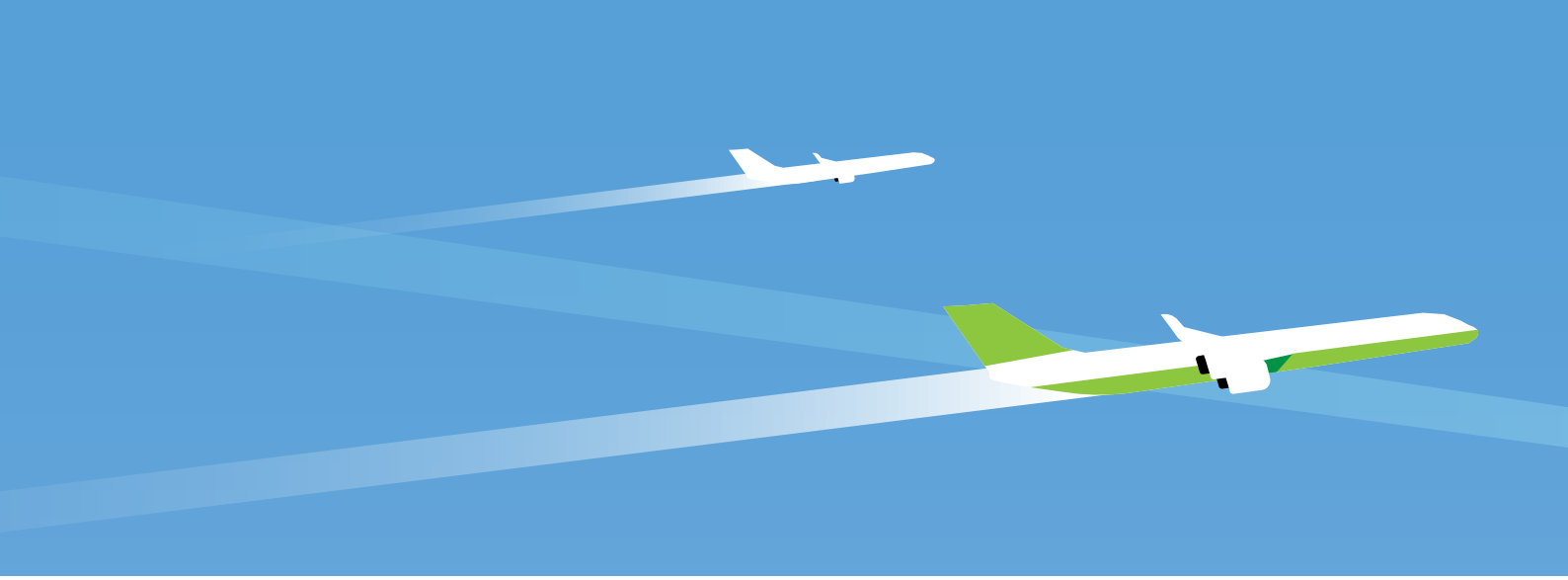
	Title	Actions	Goals / Milestones	Date
A59	**New Entrants environmental Assessments**	Complete assessment of environmental impacts of new entrants, including noise analysis for future certification, and increase availability and use of tools for environmental impact assessment of their operations	M40	2035
A60	**Formation Flying Training**	Define training requirements (Pilot and ATCO) and other tools necessary for Formation Flying techniques to receive operational deployment	M33	2030
A61	**Procedure Changes environmental impact**	Increase use of best practices by ensuring operational procedure changes are subject to environmental assessment including climate and noise impacts.	M58	2025
A62	**Formation Flying Trials**	Continuation of Formation Flying trials enable refinement of operational concept for regulatory approval	M33	2030
A63	**Weather Detection**	Improve weather detection and forecasting capability to enhance ability to forecast regions of likely persistent contrail formation	M30	2025
A64	**Contrail Avoidance**	Integrate contrail avoidance capabilities into ATM en-route toolsets and use contrail forecast data to flight plan around areas of likely contrail formation	M30	2030
A65	**Vertiport Guidance**	Develop guidance for the design, construction, operation and collection/provision of data associated with vertiports to ensure sustainability and proper integration (including minimum infrastructure and equipment according to UAS/RPAS services & operations)	M32, M67	2025
A66	**Automated Data Exchange**	Enhance approach/departure and enroute procedures through automated data exchange (e.g. Optimum Top of Descent, Target Time Over).	M16, M50	2025
A67	**FUA Application**	Negotiations with military airspace users ensure application of FUA in all regions, reducing inefficiencies.	M6, M45	2025
A68	**UAM Comms campaign**	Roll out a strong communications campaign to proactively address public concerns (privacy, noise, safety) and improve perception of increased activity in lower airspace to generate social licence for UAM and increased UAS/RPAS operations.	M40	2025
A69	**UFP Mitigation Techniques**	Wider implementation of operational techniques to mitigate UFP air quality impacts on local communities	M37	2035
A70	**UFP Mitigation Technologies**	Develop new combustion technologies for future engines with new combustion cans to mitigate UFPs	M37	2035
A71	**ATM Infrastructure Optimisation**	Optimise ground based ATM infrastructure. Convert remaining ground based ATM infrastructure and operations to zero carbon emitting.	M29	2025
A72	**Review Airspace Classification**	Conduct a review of airspace classifications	M43, M41	2025
A73	**Space Flight Guidelines**	Develop guidelines for the coordination and execution of space destined traffic between all affected (adjacent and non-adjacent) ANSPs	M44	2030
A74	**ICAO Direct Submission**	In an effort to speed-up the improvement of airspace structures, engage ICAO to make use of the direct submission mechanism to provide proposals/solutions based on trials and pilot projects.	M25	2030
A75	**Flexible Framework**	Develop a framework to support the utilisation for the flexible use of airspace	M43, M41	2025

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A76	**Dynamic Airspace procedures**	Design operational procedures for dynamic airspace management	M43, M42	2035
A77	**Test airspace concept**	Test airspace concept and update concept based on results	M18	2025, 2030, 2035, 2040
A78	**Define air traffic rules for all airspace**	Define air traffic rules for all airspace participants within a more cooperative, inclusive and proactive framework	M5	2030
A79	**Promote aviation trust framework**	Promote a mature international aviation trust framework	M49	2025
A80	**Identify authoritative data sets**	Convene forum to identify authoritative data sets for AI and Machine Learning	M15	2025
A81	**New airspace designs**	Extend global standards for aeronautical information to include minimum digital data set provision requirements needed to enable the transition to new airspace designs and the safe and efficient integration of new entrants	M41	2035
A82	**Contingency plans**	Put contingency plans in place to withstand extreme attack scenarios and prevent cascading system failures	M63	2030
A83	**Timely sharing of data**	Support and promote the digital and timely sharing of data related to wake turbulence and aircraft performance characteristics for all existing and new aircraft types to enable proper sequencing, separation and deconfliction by ATM/UTM automation systems	M50	2030
A84	**Implementation of secured communications**	Implementation of secured communications concept (e.g. Zero Trust). Cyber security is not only related to data but becomes a holistic approach to all components (Never trust, always verify) to support all interchanges, eliminating the 100% reliance on aviation spectrum	M52	2035
A85	**Enhance cyber security policy**	Enhance cyber security policy within organisations. Execute third party audits and implement continuous improvement processes	M15, M49	2025
A86	**Identify anticipated aviation spectrum needs**	Continue to coordinate with stakeholders to identify anticipated aviation spectrum needs. Once determined, support industry-wide approach needed to convince the ITU to protect those requirements	M64	2035
A87	**Diverse use-cases**	Multiple, diverse use-cases should be identified and analysed involving all-known new entrants (e.g., Supersonics, UAM, RPAS, and Commercial Space Vehicles). Analyses of these should result in a list of aeronautical information requirements needed to safety integrate these into existing and future aviation systems	M47	2030
A88	**Skills review**	Undertake a holistic review of the skills needed in future aviation systems and how these could or should come together as roles that offer a range of rewarding career paths that would be attractive to the next generation of talent. Include an assessment of existing skills gaps	M56	2025
A89	**Develop a pathway for advanced technology**	Develop a pathway for the expanded implementation of advanced technology, leveraging its benefits while ensuring effective management of risks, e.g. contingency issues, staff de-skilling, role of human in the loop, amplification of the combined strengths of humans and technology.	M9, M12	2025

CATS Global Council Vision – Identified Actions

	Title	Actions	Goals / Milestones	Date
A90	**Future ways of working**	Prepare organisations for future ways of working, including cultural transformation by: ▪ Producing an updated competency model that embodies the knowledge, skills, attitudes and behaviours needed to be successful. ▪ Promoting an enhanced and proactive industry approach to learning culture ▪ Identifying measures to increase diversity and inclusion ▪ Increasing utilisation of new technologies in training programs	M55	2025
A91	**Joint problem-solving approach in labour relations**	Implement a collaborative modern, joint problem-solving approach in labour relations	M59	2025
A92	**Robust change management**	Implement a robust change management process which includes engagement of staff	M58	2025
A93	**Champion STEM education**	Create partnerships to champion STEM education, including amongst diverse candidates.	M61, M57	2025
A94	**Enhance recruitment efforts**	Enhance recruitment efforts for systems engineers, data architects, analysts, and AI technicians.	M61	2025
A95	**New training approach**	Put in place new training approaches to accelerate learning, integrate advanced technologies and enable a continuous learning culture. Integrate the psychology of human performance into training programmes – how people learn, marginal gain theory and scenario-based training.	M57	2030
A96	**Work as done vs work as imagined**	Establish work plan to ensure understanding of the emergent properties of work as done vs work as imagined in the future aviation ecosystem and ensure learnings are integrated into system design	M56	2025
A97	**Integrate Human Factors Assurance**	Integrate Human Factors Assurance into the process of certifying and creating standards for technology innovations.	M1	2025
A98	**Organisational agility**	Identify and implement mechanisms to increase organisational agility within the industry	M58	2025
A99	**Human in the loop capabilities**	Establish and implement a programme of education regarding human in the loop capabilities, also including analysis to evaluate how people can keep focus in a highly automated environment when they are required to react quickly	M1, M63	2025
A100	**Redistribution of tasks**	Research is undertaken based on emerging service models and CONOPS to define tasks likely to remain with humans vs those most suited to application of technology	M1	2025



Next Activities of the CATS Global Council

The work of the CATS Global Council is not done. Industry members will take ownership of progress and will keep the roadmap a living document, adjusting in line with new technologies and important global and regional developments to ensure it remains fit for purpose.

In the next phase, the CATS Global Council will start working on some of the key milestones from the vision roadmap. New sub groups will be formed to progress certain tasks identified in the roadmap and continue to provide the necessary cross industry leadership to maintain momentum and accountability.

Implementing the roadmap is a challenging task, but it will allow the industry to co-ordinate, focus and prioritise its energies on the right things that need to be done to realise our future sky vision.

CANSO invites all organisations across the manned and unmanned aviation industries to be part of the effort.

For more information please contact

deborah.seymour@canso.org

eduardo.garcia@canso.org

For more information and the latest news, please visit

futureskyvision.com