Collaborative Actions for Renovation of Air Traffic Systems 2040（CARATS2040）

～ A Challenge Towards Realizing Japan’s Innovative Air Traffic Management Systems ～

June, 2025

Council for Promotion of the Future Air Traffic System

Purpose

In Japan, the Long-Term Vision for Future Air Traffic Systems, a program referred to "CARATS：Collaborative Actions for Renovation of Air Traffic Systems" program was established in 2010 with an initial implementation year of 2025 establishing the future direction of air traffic systems in Japan.

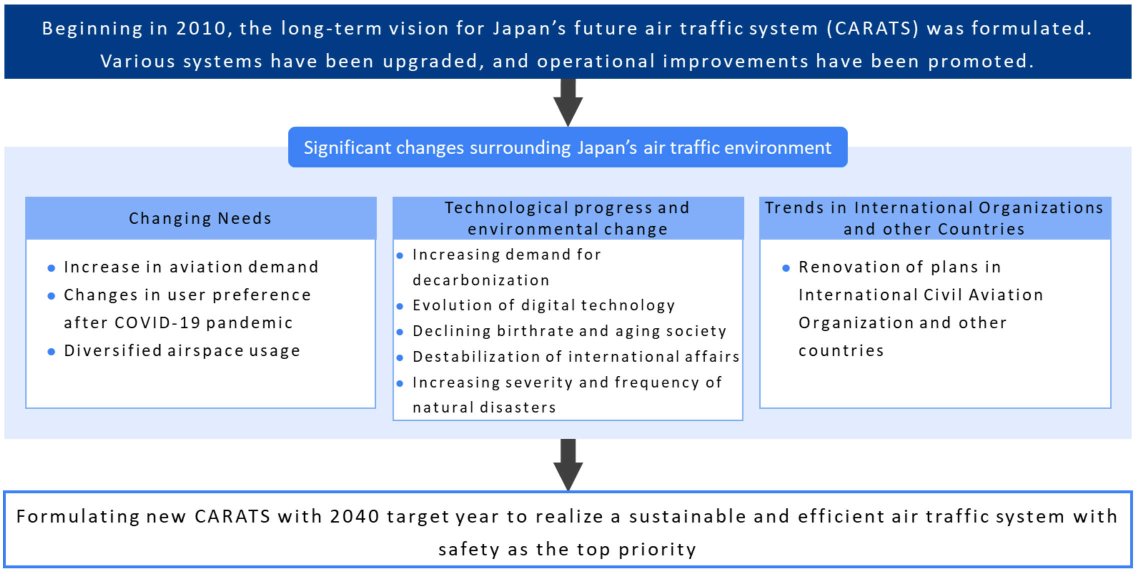
Since then, efforts have been made to restructure domestic controlled airspace, introduce data communications, and upgrade communications, navigation, surveillance technologies, and information systems towards improving air traffic operations.

Since the initial establishment of CARATS, the environment surrounding Japan's air traffic system has undergone significant changes. Along with increases in air traffic demand, there are other significant changes such as shifts in airline user's preferences due to the COVID-19 pandemic, diversification of airspace utilization needs, growing demands for decarbonization, advancements in digital technology, impacts from declining birthrate and an aging society in Japan, instability in the international affairs, and intensification and increased frequency of natural disasters.

Additionally, the International Civil Aviation Organization (ICAO) is revising its Global Air Transport Plan with a target year of 2040 to drive transformation of aviation transportation systems. Likewise, European, American, and Asian countries are also reviewing their long-term plans to address current challenges.

In Japan, we recognize safety should be the top priority the need to respond appropriately to these changes and to realize an efficient and sustainable air transportation system. Therefore we decided to formulate the next iteration CARATS with a target implementation year of 2040.

Figure 0-1 Development Process of the New CARATS



Beginning in 2010, the long-term vision for Japan’s future air traffic system (CARATS) was formulated. Various systems have been upgraded, and operational improvements have been promoted.

Significant changes surrounding Japan’s air traffic environment

Changing Needs

- Increase in aviation demand
- Changes in user preference after COVID-19 pandemic
- Diversified airspace usage

Technological progress and environmental change

- Increasing demand for decarbonization
- Evolution of digital technology
- Declining birthrate and aging society
- Destabilization of international affairs
- Increasing severity and frequency of natural disasters

Trends in International Organizations and other Countries

- Renovation of plans in International Civil Aviation Organization and other countries

Formulating new CARATS with 2040 target year to realize a sustainable and efficient air traffic system with safety as the top priority

Contents

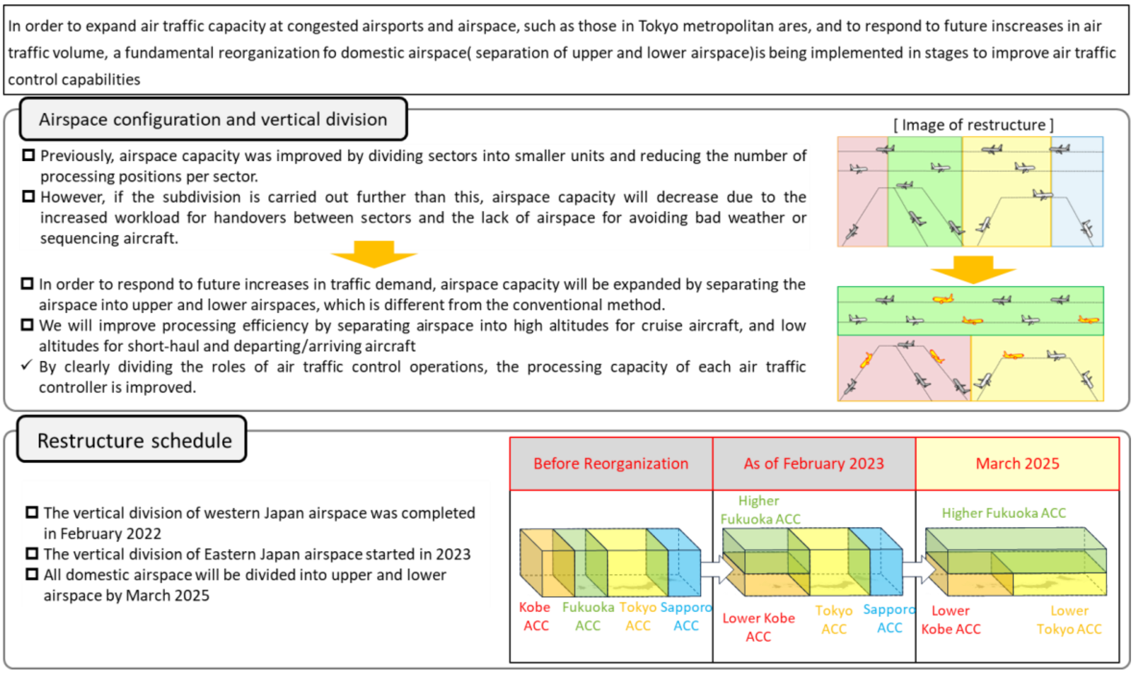
1. Background

(1) Background of our efforts to date

In Japan, we have applied the CARATS program towards restructuring domestic controlled airspace and introduce new air navigation technologies and operational methods in order to deal with the increase of traffic volume and improve aviation safety and convenience.

For example, in order to accommodate future increases in traffic volume, including aircraft overflight, we have been working to restructure domestic controlled airspace while carefully considering airspace configurations and other related factors. We have implemented phased vertical separation of controlled airspace, and finally completed national airspace reorganization in March 2025 (Figure 1-1). Particular to this phased approach, we implemented the above mentioned measures in the western Japan airspace from 2020, and in the eastern Japan airspace from 2023.

Figure 1-1 Restructuring of Domestic Airspace



In order to expand air traffic capacity at congested airsports and airspace, such as those in Tokyo metropolitan ares, and to respond to future inscreases in air traffic volume, a fundamental reorganization fo domestic airspace(separation of upper and lower airspace)is being implemented in stages to improve air traffic control capabilities

Airspace configuration and vertical division

☐ Previously, airspace capacity was improved by dividing sectors into smaller units and reducing the number of processing positions per sector.

☐ However, if the subdivision is carried out further than this, airspace capacity will decrease due to the increased workload for handovers between sectors and the lack of airspace for avoiding bad weather or sequencing aircraft.

☐ In order to respond to future increases in traffic demand, airspace capacity will be expanded by separating the airspace into upper and lower airspaces, which is different from the conventional method.

☐ We will improve processing efficiency by separating airspace into high altitudes for cruise aircraft, and low altitudes for short-haul and departing/arriving aircraft

✓ By clearly dividing the roles of air traffic control operations, the processing capacity of each air traffic controller is improved.

Restructure schedule

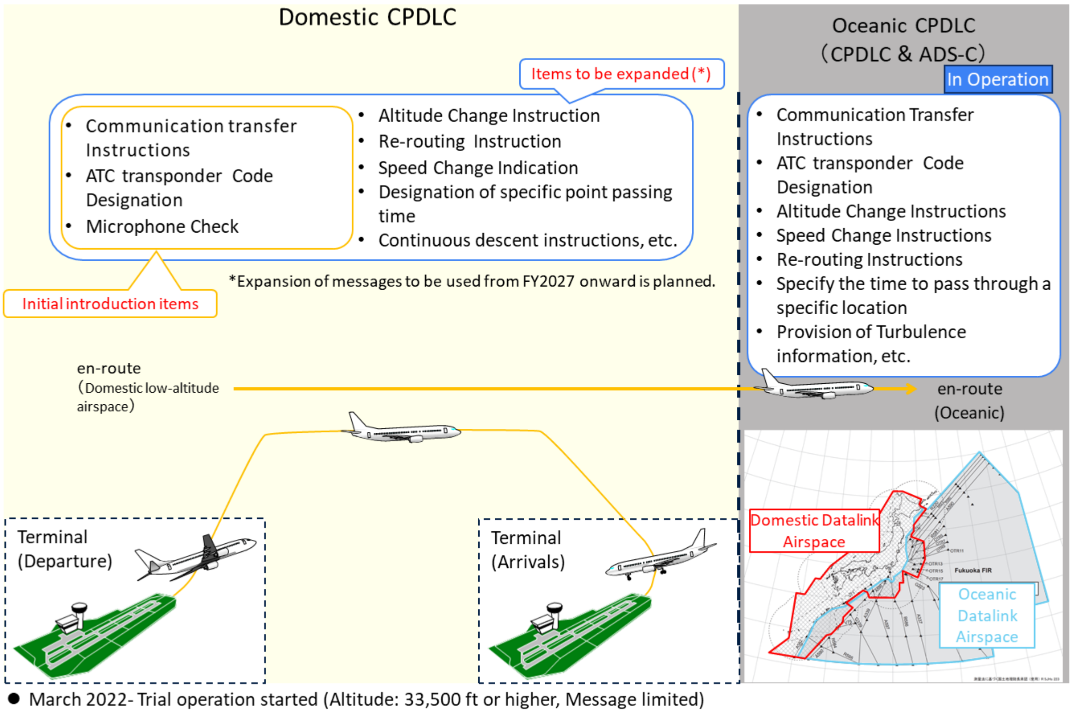
☐ The vertical division of western Japan airspace was completed in February 2022

☐ The vertical division of Eastern Japan airspace started in 2023

☐ All domestic airspace will be divided into upper and lower airspace by March 2025

Additionally, to reduce the workload of both air traffic controllers and pilots, the trial use of CPDLC was expanded, which replaces some voice communications with data communications. Trial operations of CPDLC[1] began in 2022 in domestic airspace in addition to operations in oceanic airspace and officially transitioned to full-scale operations in 2023 (Figure 1-2).

Figure 1-2 CPDLC procedures in FUKUOKA FIR



- March 2022- Trial operation started (Altitude: 33,500 ft or higher, Message limited)
- March 2023- Formal operation started(Altitude: unlimited (except terminal airspace), Message limited)

The work to achieve Trajectory-based operations[2](TBO) are also steadily progressing both in Japan and overseas. Information sharing among ATM[3] stakeholders is essential for flexible and efficient aircraft operations.

In 2023, the MR TBO project[4], a joint initiative between Japan, the United States, Singapore, and Thailand, conducted test flights using aircraft equipped with next-generation technology prototypes and identified operational issues related to TBO.

Going forward, it is planned to expand the number of participating countries in the Asia-Pacific region to conduct demonstration tests. Additionally, detailed discussions are underway among industry, academia community, and Japan Civil Aviation Bureau

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[1] CPDLC (Controller Pilot Data Link Communications): A system that uses text information instead of voice communication for exchanges between air traffic controllers and pilots.

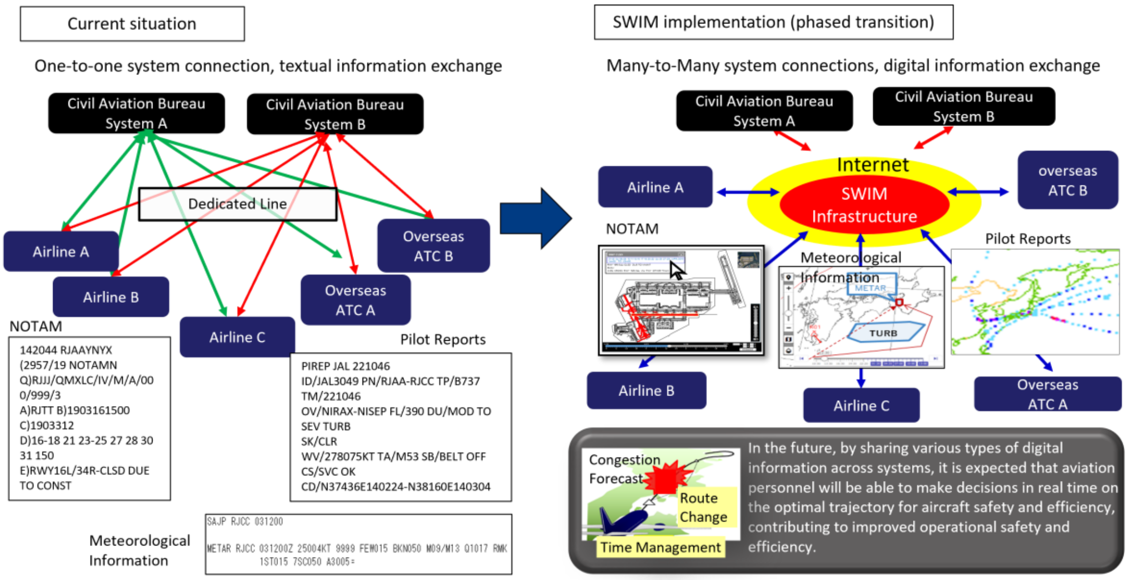
[2] TBO (Trajectory Based Operations): A concept for optimal air traffic control operations based on real-time sharing of aircraft trajectories with air traffic controllers and aviation stakeholder using digital technology.

[3] ATM (Air Traffic Management): The collective term for airspace management, air traffic flow management, and air traffic operations necessary to ensure safe and efficient operations at all stages of aircraft operations.

[4] MR TBO (Multi-Regional Trajectory Based Operations) Project: A project that validate the TBO concept through operation using actual passenger aircraft, based on testing activities conducted in a laboratory environment and in collaboration with four countries' air traffic control units.

(JCAB) regarding the central role of aviation information sharing infrastructure platform (SWIM)[5], including details of related information services and security management. Initial SWIM services are scheduled to begin in 2025 in Japan (Figure 1-3).

Figure 1-3 SWIM Information Service



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In the future, by sharing various types of digital information across systems, it is expected that aviation personnel will be able to make decisions in real time on the optimal trajectory for aircraft safety and efficiency, contributing to improved operational safety and efficiency.

In the airport environment, the Airport Low-Level Wind Information (ALWIN)[6] began implementation in 2017 to enrich the provided information on wind conditions along airport approach paths. This enables real-time access to detailed information such as wind speed and direction both on board aircraft and on the ground, contributing to improved aviation safety. Additionally, efforts are being made to expand the implementation of satellite-based approach procedures, with the necessary equipment being prepared and introduced in a planned manner among collaboration between industry, academia partners, and JCAB. Since 2021, RNP-AR[7] approach procedures using GNSS[8] information have been introduced at 40 airports, and LP/LPV approach procedures[9] at 25 airports. In

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[5] SWIM (System Wide Information Management): A system that manages information across systems to enable aviation stakeholders to access reliable information services in a trustworthy environment. It is established by providing the information required by stakeholders as a service.

[6] ALWIN (Airport Low-level Wind Information): Information on low-level winds along the approach path, created from observations made by devices (airport weather Doppler radar and lidar) that measure the distribution of wind based on the movement of raindrops and dust in the air. Provided in image and text formats.

[7] RNP-AR approach procedure (Required Navigation Performance - Authorization Required): An instrument approach procedure that complies with specified navigation performance and functional requirements. Note that special flight authorization is required for flights using this procedure.

[8] GNSS (Global Navigation Satellite System): A global navigation satellite system. By capturing three navigation satellites (GNSS orbiting satellites) from an aircraft, the distance from each satellite can be obtained, and by synchronizing the time using signals from a fourth navigation satellite, the three-dimensional flight position of the aircraft could be determined.

[9] LP/LPV approach procedure (Localizer Performance/Localizer Performance with Vertical Guidance): An approach procedure that uses satellite navigation augmentation systems to transmit GNSS information via geostationary satellites to aircraft in order to supplement positioning accuracy and reliability.

January 2025, GLS approach procedures[10] also began operations at Tokyo International Airport (Figures 1-4, 1-5, 1-6). These initiatives are contributing to improved aviation utility by enabling more efficient route planning and increased landing opportunities during adverse weather conditions.

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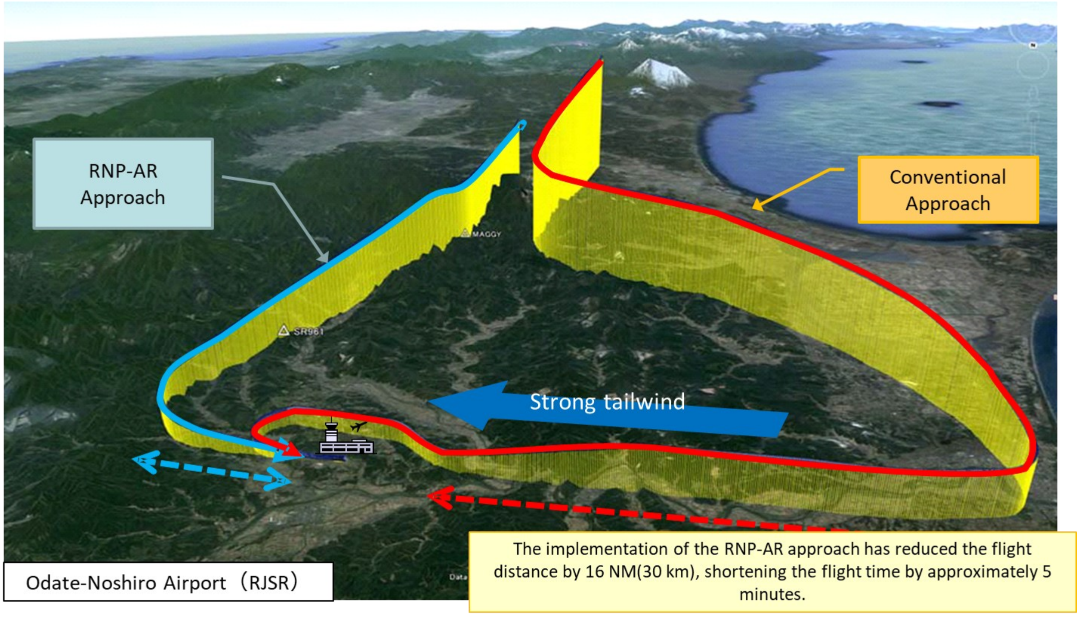
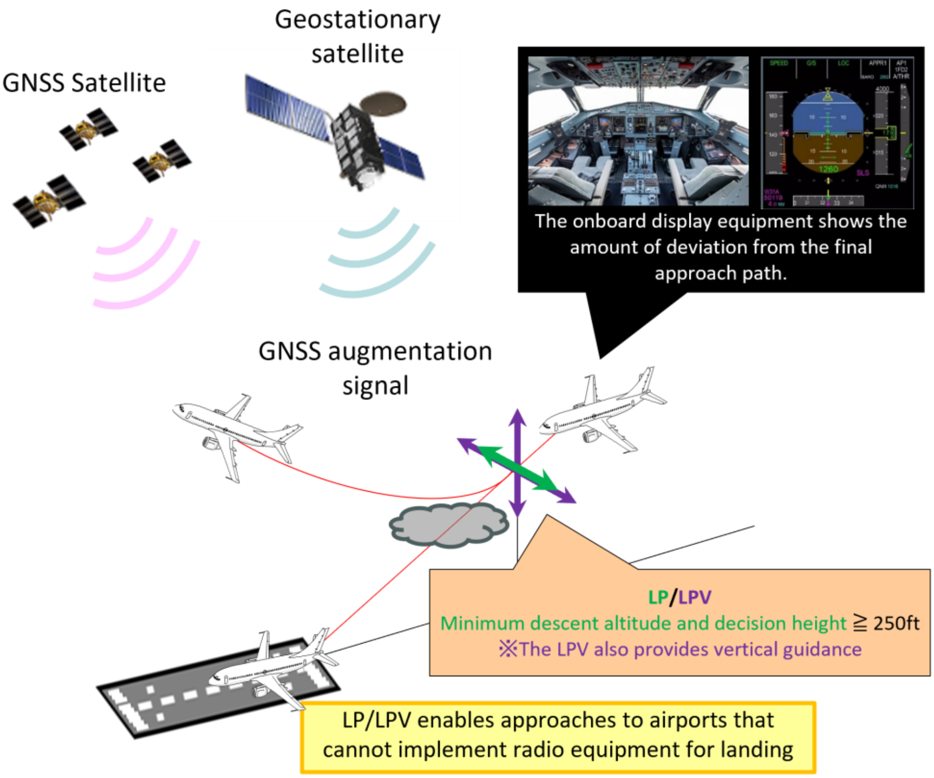
[10] GLS approach procedure (Ground-Based Augmentation System Landing System): An approach procedure that uses satellite navigation augmentation systems to transmit GNSS information from the ground to aircraft to supplement positioning errors and reliability.

Figure 1-4 RNP-AR approach procedure



The implementation of the RNP-AR approach has reduced the flight distance by 16 NM(30 km), shortening the flight time by approximately 5 minutes.

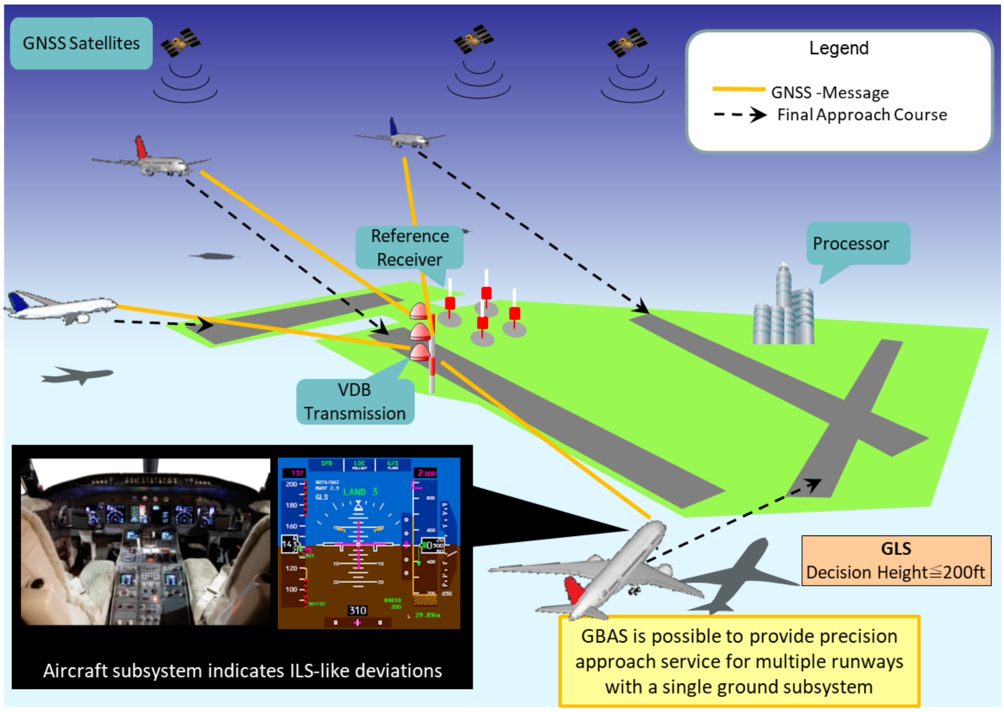
Figure 1-5 LP/LPV approach procedure



The onboard display equipment shows the amount of deviation from the final approach path.

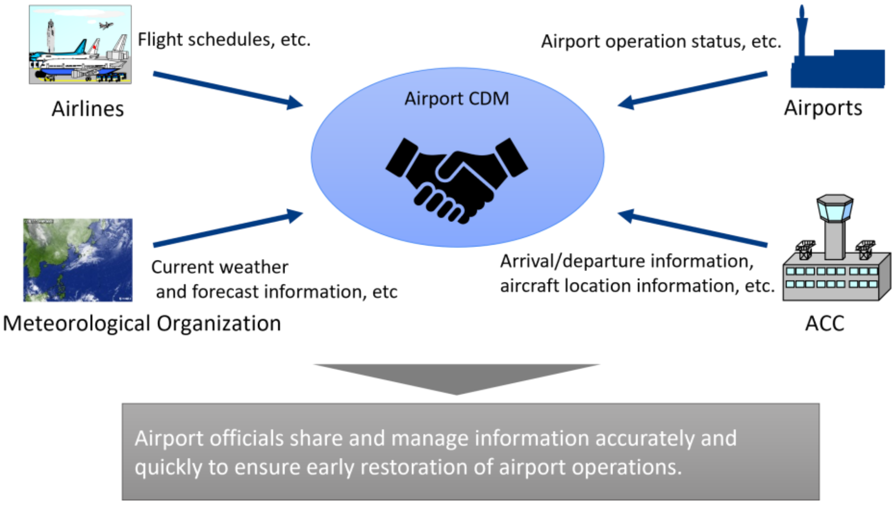
LP/LPV enables approaches to airports that cannot implement radio equipment for landing

Figure 1-6 GLS approach procedure



Collaborative decision-making (airport CDM[11]) at Tokyo International Airport, Narita International Airport and New Chitose Airport, which has been introduced to share flight information and airport operational information among relevant parties, is contributing to improved airport operations (Figure 1-7).

Figure 1-7 Airport CDM



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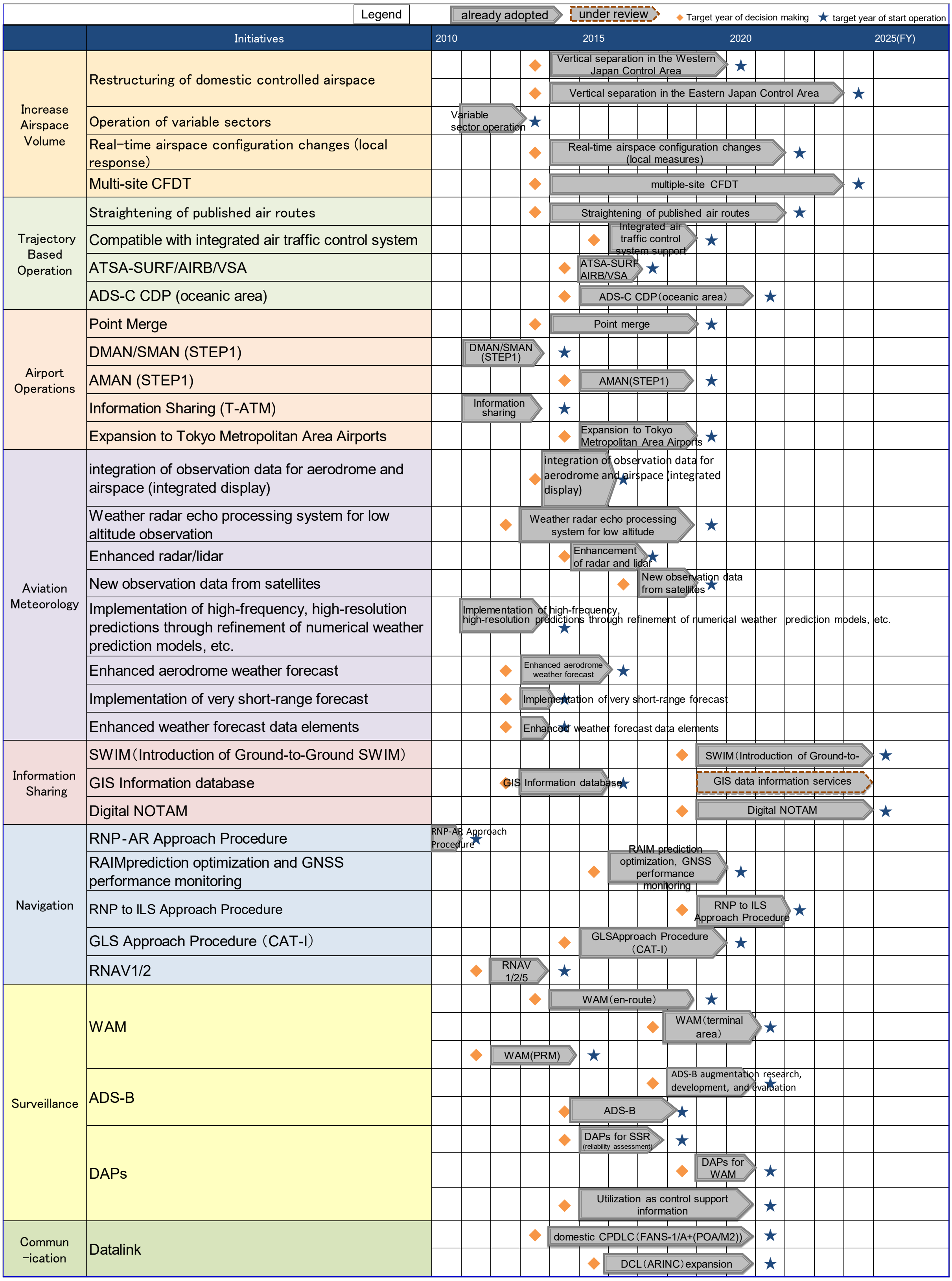
[11] Airport CDM (Airport Collaborative Decision Making): To optimize airport resources by improving the accuracy of departure and arrival flight operations and the predictability of various events in airport operations, airport stakeholders share and manage information accurately and quickly.

Figure 1-8 Progress of CARATS's main initiatives



	Initiatives	2010 2015 2020 2025(FY)
Increase Airspace Volume	Restructuring of domestic controlled airspace	Vertical separation in the Western Japan Control Area Vertical separation in the Eastern Japan Control Area
	Operation of variable sectors	Variable sector operation
	Real−time airspace configuration changes (local response)	Real-time airspace configuration changes (local measures)
	Multi-site CFDT	multiple-site CFDT
Trajectory Based Operation	Straightening of published air routes	Straightening of published air routes
	Compatible with integrated air traffic control system	Integrated air traffic control system support
	ATSA-SURF/AIRB/VSA	ATSA-SURF AIRB/VSA
	ADS-C CDP (oceanic area)	ADS-C CDP(oceanic area)
Airport Operations	Point Merge	Point merge
	DMAN/SMAN (STEP1)	DMAN/SMAN (STEP1)
	AMAN (STEP1)	AMAN(STEP1)
	Information Sharing (T-ATM)	Information sharing
	Expansion to Tokyo Metropolitan Area Airports	Expansion to Tokyo Metropolitan Area Airports
Aviation Meteorology	integration of observation data for aerodrome and airspace (integrated display)	integration of observation data for aerodrome and airspace (integrated display)
	Weather radar echo processing system for low altitude observation	Weather radar echo processing system for low altitude
	Enhanced radar/lidar	Enhancement of radar and lidar
	New observation data from satellites	New observation data from satellites
	Implementation of high-frequency, high-resolution predictions through refinement of numerical weather prediction models, etc.	Implementation of high-frequency, high-resolution predictions through refinement of numerical weather prediction models, etc.
	Enhanced aerodrome weather forecast	Enhanced aerodrome weather forecast
	Implementation of very short-range forecast	Implementation of very short-range forecast
	Enhanced weather forecast data elements	Enhanced weather forecast data elements
Information Sharing	SWIM(Introduction of Ground-to-Ground SWIM)	SWIM(Introduction of Ground-to-
	GIS Information database	GIS Information database GIS data information services
	Digital NOTAM	Digital NOTAM
Navigation	RNP-AR Approach Procedure	RNP-AR Approach Procedure
	RAIMprediction optimization and GNSS performance monitoring	RAIM prediction optimization, GNSS performance monitoring
	RNP to ILS Approach Procedure	RNP to ILS Approach Procedure
	GLS Approach Procedure（CAT-I)	GLSApproach Procedure (CAT-I)
	RNAV1/2	RNAV 1/2/5
Surveillance	WAM	WAM(en-route) WAM(terminal area) WAM(PRM)
	ADS-B	ADS-B augmentation research, development, and evaluation ADS-B
	DAPs	DAPs for SSR (reliability assessment) DAPs for WAM Utilization as control support information
Commun−ication	Datalink	domestic CPDLC(FANS-1/A+(POA/M2)) DCL(ARINC)expansion

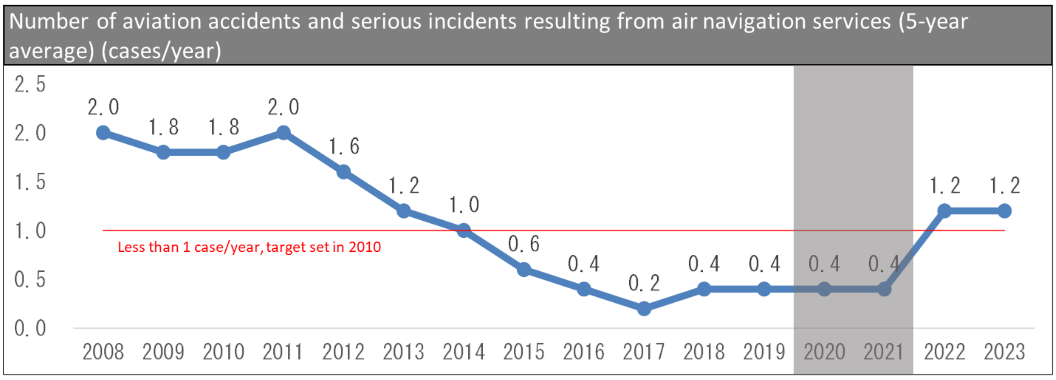
(2) Present Circumstances and challenges

① Safety and Security

Safety is the fundamental and most important consideration to an air traffic system[12]. Once an aviation accident occurs, it could result in the loss of numerous lives, causes significant social and economic losses and could also severely undermine public trust in aviation. To date, both air traffic control units and operators have implemented safety management systems (SMS)[13] and advanced modernization of control systems, resulting in a long-term reduction in aviation accidents and serious incidents attributable to air navigation services[14] (Figure 1-9). However, incidents such as runway incursions continue to occur, many involving human error. Therefore, further risk reduction measures are necessary, to include the utilization of digital technology (Figures 1-10 and 1-11).

Additionally, the use of unmanned aircraft and advanced air mobility are expected to expand in low-altitude airspace, while new entrants such as HAPS[15] and reusable launch vehicles will emerge in high-altitude airspace in the near future. In these circumstances, it will be necessary to ensure safety and security across the entire airspace system, including sustainably adopting these new types of air mobility.

Figure 1-9 Trends in safety indicators



Note: Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so figures are shown for reference only.

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[12] Air traffic systems: Air traffic management conducted to ensure safe, efficient and smooth air traffic, as well as the aircraft equipment, and ground- and satellite-based facilities required for this purpose.

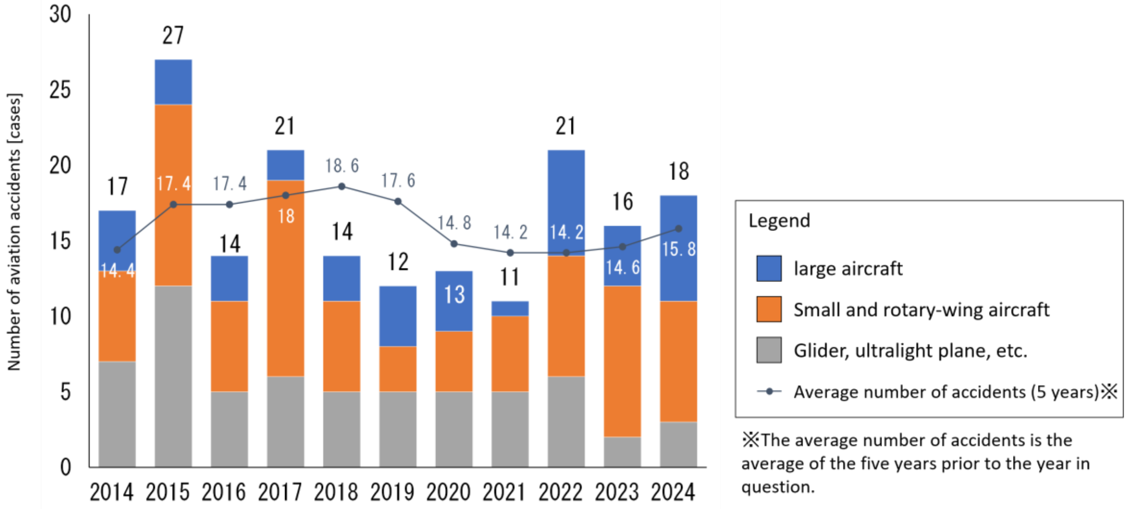
[13] SMS (Safety Management System): A proactive initiative to identify potential hazards that could lead to accidents or incidents, evaluate the risks posed by those hazards, and implement measures to reduce those risks to an acceptable level.

[14] Air Navigation Services: Various operations conducted to support the safe and efficient operation of aircraft. These include Air Traffic Control Service, Air Traffic Information Communication Service, Air Traffic Engineering Services, Visual Aids and Electrical Systems Services, Flight Inspection Services, and Secondary Power Systems Services of Air Navigation Service.

[15] HAPS (High Altitude Platform Station): A stratospheric platform. An unmanned aircraft system equipped with communication equipment, which are kept aloft in the stratosphere, where weather conditions are relatively stable, to provide communication services, etc.

1. Background

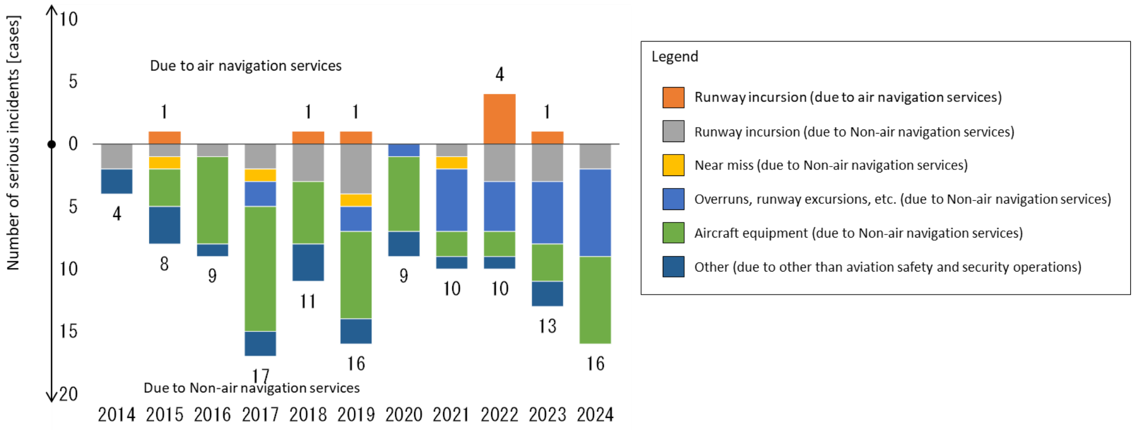
Figure 1-10 Trends in the number of accidents



※The average number of accidents is the average of the five years prior to the year in question.

Source: According to Japan Civil Aviation Bureau, based on materials from the Japan Transport Safety Board.

Figure 1-11 Trends in the number of serious incidents



Note 1) Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so these figures are provided for reference only.

Note 2) The metropolitan area surrounding airspace refers to the air route sectors handling air traffic around airports in metropolitan area.

Note 3) The maximum number of aircraft that can be handled is the total number of aircraft that can be handled in the air route sectors of the metropolitan area surrounding airspace and does not necessarily correspond to the number of aircraft permitted to take off or land at metropolitan area airports.

Source: According to Japan Civil Aviation Bureau, based on materials from the Japan Transport Safety Board.

② Use of Airspace

In our country, efforts have been made to expand air traffic control capacity by restructuring domestic airspace, among other measures. Meanwhile, traffic volume has largely recovered to pre-pandemic levels following a significant decline during the COVID-19 pandemic (Figure 1-12). Looking ahead, further increase in traffic volume is anticipated, particularly driven by economic growth in neighboring Asian regions and the expansion of low-cost carrier (LCC) operations, with international flights expected to lead the way. To address this, it is essential to continue expanding capacity through alleviating congestion at airports and airspace, to include in the Tokyo metropolitan area, and by implementing flexible adjustments to airspace configurations and establishing new flight routes utilizing advanced technologies.

In recent years, discussions have been progressing on the introduction of the next generation of air mobility across a wide range of airspace, from low altitudes (less than 150 meters) to high altitudes (FL[16] 600 or higher). For example, "LEVEL 4" flight[17] operations became possible in 2022, and discussions are currently underway in public-private committee and other bodies to further advance the use of Unmanned Aircraft. Concurrently, research and development of advanced air mobility are progressing, and the EXPO2025 Osaka, Kansai, Japan, scheduled in April 2025, accelerated the diversification of airspace utilization needs, triggered by the introduction of advanced air mobilities conducting flight operations around the venue. More precise air traffic management is required to address the increasing demand for the next generation air mobility and ensure integrated airspace management with existing aircraft.

However, securing limited spectrum resources has become an issue due to the entry of the next generation of air mobility services, in addition to growing demand for frequencies outside the aviation sector.

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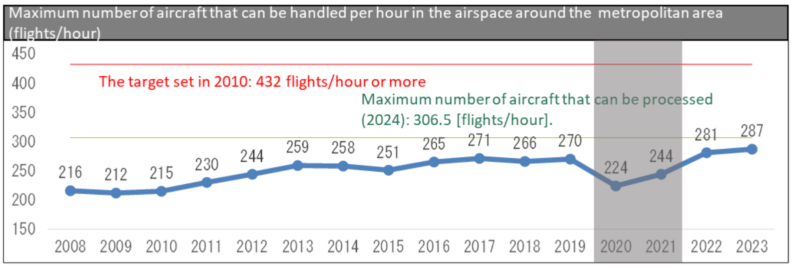
[16] FL (Flight Level): An isobaric value based on a standard atmospheric pressure of 1,013.2 hectopascals (29.92 inches of mercury). In Japan, FL is used to indicate altitudes of 14,000 ft or higher.

[17] Level 4 flight operations: Unmanned aircraft flight beyond visual line of sight in an inhabited area (which means the UA will fly over third Parties) without a visual observer as an assistant.

Figure 1-12 Trends in indicators related to measures to increased air traffic



Ref. (Number of allowed processing in the airspace around the metropolitan area)

Maximum aircraft that can be processed (2008)
256.3 [flights/hour]
Maximum aircraft that can be processed (2024)
306.5 [flights/hour]

※Further airspace realignment could increase ATC processing capacity

Note 1) Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so these figures are provided for reference only.

Note 2) The metropolitan area surrounding airspace refers to the air route sectors handling air traffic around airports in metropolitan area.

Note 3) The maximum number of aircraft that can be handled is the total number of aircraft that can be handled in the air route sectors of the metropolitan area surrounding airspace and does not necessarily correspond to the number of aircraft permitted to take off or land at metropolitan area airports.

③ Utility

To enhance aviation convenience, we have been promoting the introduction of RNP-AR approach procedures, LP/LPV approach procedures, airport CDM, and AMAN/DMAN/SMAN[18].

However, in recent years, due to the increase in traffic volume and a concentration and uneven distribution of traffic flows at specific altitudes and sectors, operational efficiency aircraft on-time performance have declined. Additionally, there has been a decrease in flight availability and punctuality due to the intensification and increased frequency of natural disasters (Figure 1-13).

On the other hand, major cities in Japan are connected via a world-renowned high-speed rail network, the Shinkansen. It is expected that the competitive environment surrounding domestic air transportation will undergo structural improvements in the future due to the extension of the Shinkansen and the development of new rail networks, such as the Linear Chuo Shinkansen (New bullet train in Japan).

In this context, Japan's air transportation is expected to provide even higher levels of utility than before, and it is also expected to serve as an alternative means of transportation in the event of disasters.

Furthermore, as Japan faces a significant population decline and an aging society, there is growing interest in advanced air mobilities as a new option to meet the transport needs of elderly people, along with others who have difficulty traveling in rural areas. Advanced air mobility may also address increasing demand for travelers to such destinations, addressing growth in tourism and the diverse mobility needs within both rural and city area to improve the business environment.

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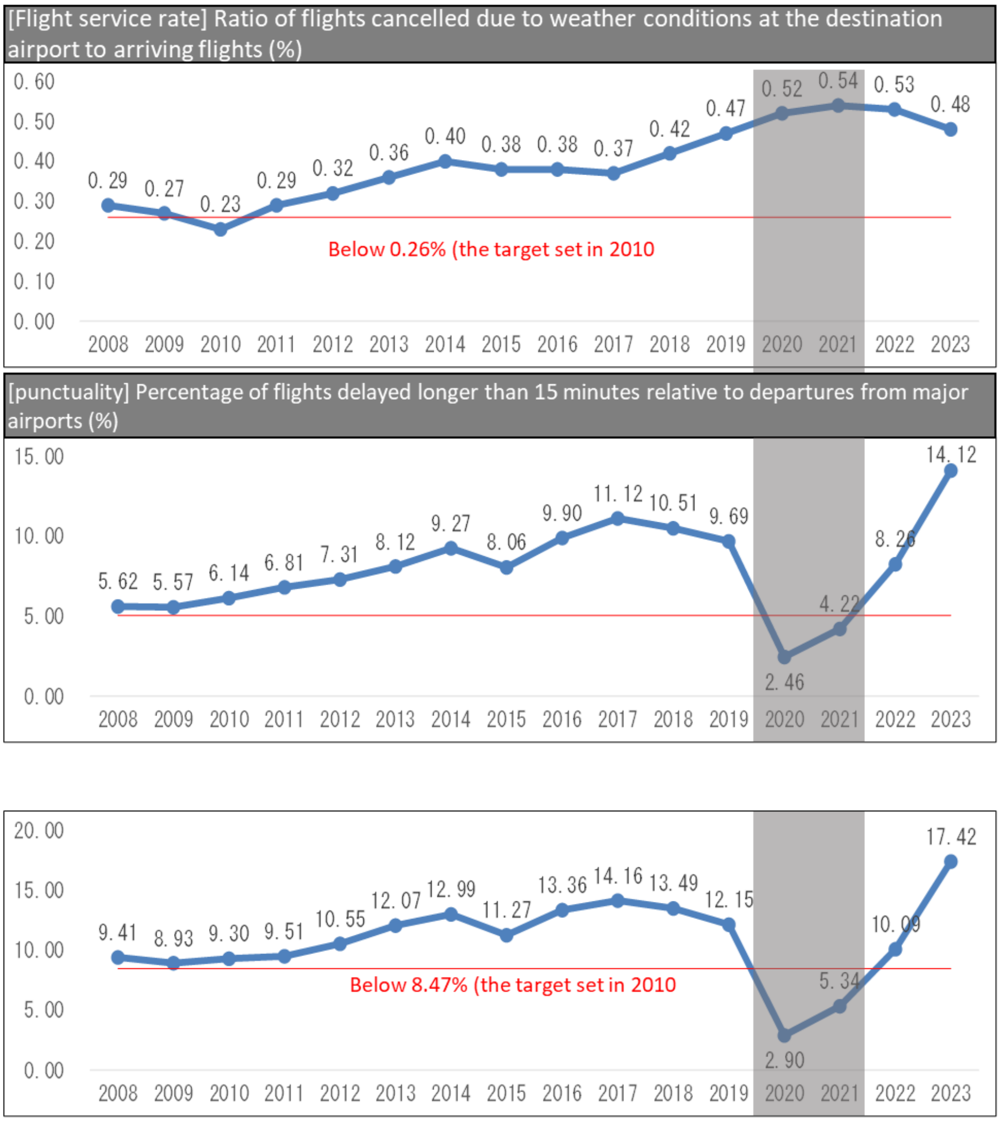
[18] AMAN/DMAN/SMAN (Arrival Manager/Departure Manager/Surface Manager): Managing the air traffic to maximizes airport capacity by predicting the information of the aircrafts during the departure, arrival, and ground movement phases.

Figure 1-13 Changes in convenience indicators



Note: Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so figures are shown for reference only.

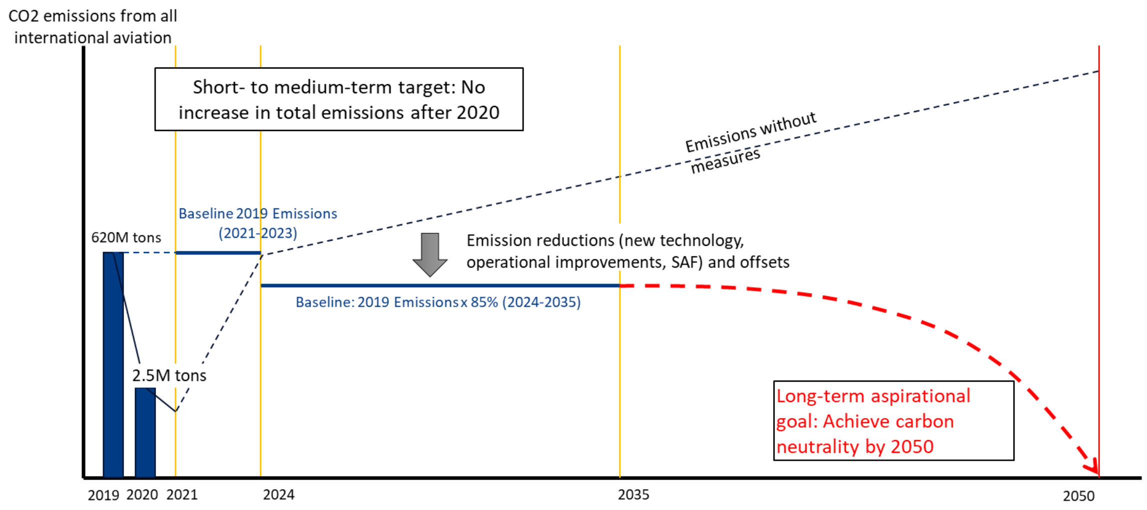
④ Operational Efficiency and the Environment

ICAO[19] is advancing discussions toward achieving carbon neutrality (LTAG)[20], and there is growing social demand for decarbonization in the aviation sector (Figure 1-14). Implementing global warming countermeasures is a common challenge worldwide, and Japan is also required to take measures toward achieving carbon neutrality by 2050. Given the expected increase in traffic volume, it is necessary to further intensify efforts to reduce CO2 emissions, and additionally, it is important to consider other factors besides CO2 that may influence global warming.

Furthermore, due to rising fuel prices and other factors, efforts to reduce fuel consumption for operational cost reduction are becoming increasingly important, making improvements in operational efficiency even more critical (Figures 1-15, 1-16, and 1-17).

Furthermore, aircraft noise mitigation measures remain an important challenge, and it is necessary to actively pursue noise reduction solutions while securing the understanding and cooperation of local communities.

Figure 1-14 ICAO Long-Term Aspirational Goals (LTAG)



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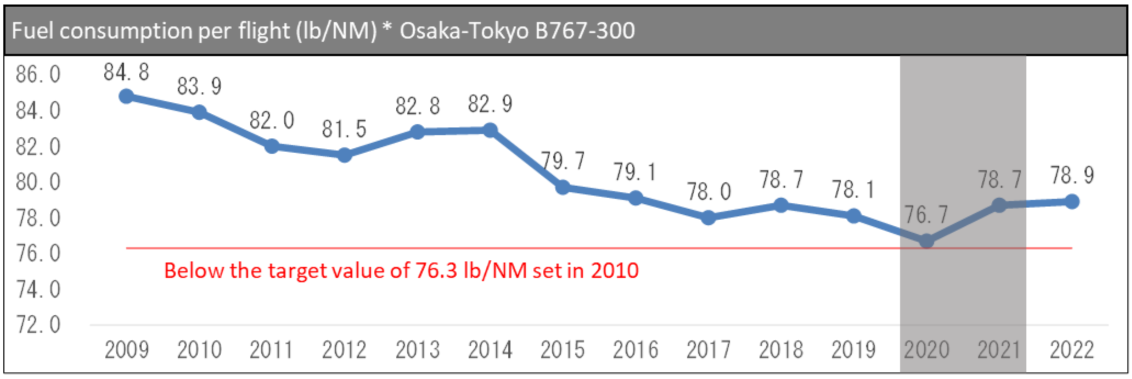
[19] ICAO (International Civil Aviation Organization): The International Civil Aviation Organization. Established in 1944 based on the Chicago Convention (officially known as the Convention on International Civil Aviation), the ICAO is a specialized agency of the United Nations. Its purpose is to promote the cooperation of states in order to ensure the safety and orderly development of international civil aviation and the sound and economic operation of international air transport on the basis of equality of opportunity.

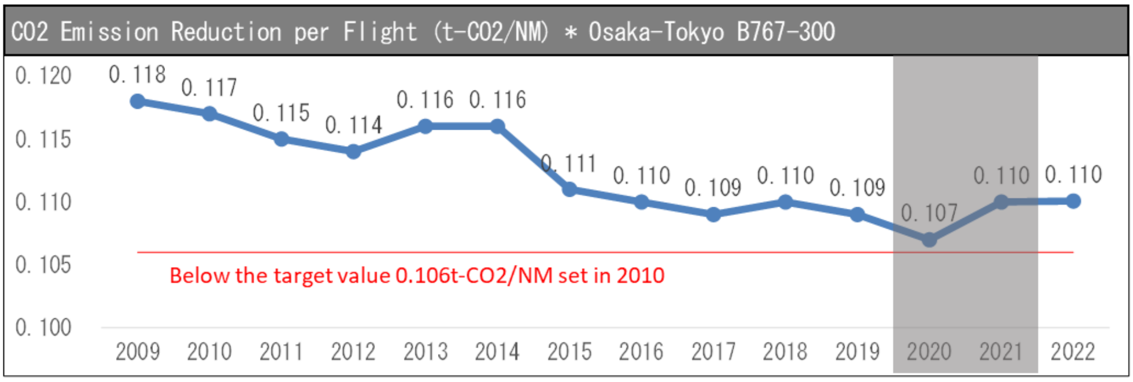
[20] LTAG (Long-Term global Aspirational Goal): A long-term goal adopted at the 41st ICAO Assembly in 2022, aiming to achieve net-zero CO2 emissions from international aviation by 2050.

Figure 1-15 Trends in operational efficiency indicators



Note: Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so figures are shown for reference only.

Figure 1-16 Trends in environmental indicators



Note: Due to the impact of COVID-19, direct comparisons are difficult for 2020 and 2021, so figures are shown for reference only.

Figure 1-17 Jet Fuel Price Trends (Left) and Fuel Costs as a Percentage of Airline Operating Expenses (Right)

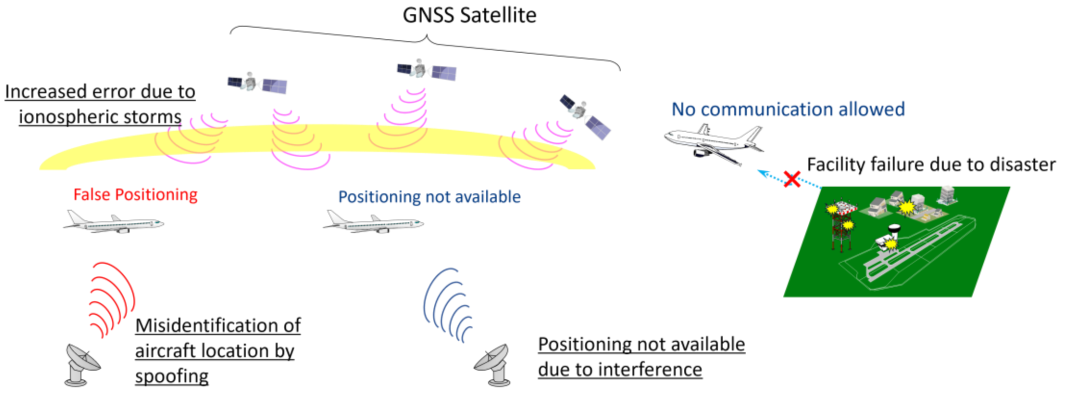
Source: U.S Energy Information Administration "U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price FOB (Dollars per Gallon)"
IMF "IMF Exchange Rates"
Based on financial results for fiscal year 2023 at selected Japanese airlines (those that disclose information)

⑤ Stability and Reliability

Air traffic systems are the foundation of air transportation, and any disruption in their functionality will lead to significant negative economic and social impacts. Therefore, it is essential to ensure their stability and reliability while minimizing the impact on operations in the event of unforeseen circumstances.

In recent years, as aviation transportation systems have become more advanced and complex, over-dependence on aircraft operation systems, application of air traffic control operational standards, and CNS[21] systems have increased significantly. In this context, threats such as major failures to satellite communication systems, jamming or spoofing against GNSS signals, and cyberattacks have grown increasingly severe. Furthermore, in addition to large-scale system failures, the intensification and increased frequency of natural disasters have led to cases where air navigation facilities[22] and equipment failures have occurred, significantly affecting operations (Figure 1-18). As an emergency response, airport operating hours have been flexibly extended, and aeronautical safety personnel have been dispatched to affected airports as emergency response teams (TEC-FORCE[23]) to actively support disaster recovery efforts.

Figure 1-18 Satellite Navigation (Left) and Communication Facility Failures Due to Disasters (Right)



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[21] CNS:Stands for Communication, Navigation, and Surveillance.

[22] Air Navigation Facility： Facilities that assist aircraft navigation using radio waves, lights, colors, or shapes.

[23] TEC-FORCE:Technical Emergency Control FORCE,is Anthe organization of Ministry of Land, Infrastructure, Transport and Tourism that works to quickly assess damage, prevent the occurrence and spread of damage, and facilitate the early recovery of disaster-affected areas during large-scale natural disasters, while supporting local governments.

⑥ International collaboration

In other countries, efforts are underway to formulate and revise long-term modernization plans, with a focus on responding to the next generation of air mobility and introduction of new digital technologies.

ICAO established the Global Aviation Safety Plan (GASP)[24] in 1997 with the aim of globally improving aviation safety. The GASP has recently been updated every three years, identifying high-risk incidents such as runway incursions, runway excursions, mid-air collisions, loss of control in flight, and controlled flight into terrain. Separately, the ICAO Global Air Navigation Plan (GANP)[25] is scheduled to be revised in 2025, incorporating additional perspectives such as environmental responsiveness and resilience[26], as well as the utilization of Artificial Intelligence (AI) technology.

In the United States, discussions are underway to realize TBO, improve airport infrastructure, enhance safety and security, and introduce next generation air mobility. A future plan succeeding NextGen[27] is scheduled to be formulated by 2027.

In Europe, the SESAR[28] revised its master plan in 2024. This plan focuses particularly on digitalization and reducing environmental impact reduction. The technical elements necessary to achieve this include TBO, greater data volumes, higher levels of automation, human–machine teaming, and dynamic airspace solutions.

In the Asia-Pacific region, the ICAO's regional air traffic plan (APAC ANP)[29] includes implementation policies for ATM and CNS, addressing issues such as information security measures. Discussions are also underway regarding SWIM and FF-ICE[30]

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[24] GASP (Global Aviation Safety Plan): A plan aimed at improving aviation safety and related areas in ICAO member states. It seeks to continuously reduce the risk of fatal accidents through the development and implementation of regional and national aviation safety plans.

[25] GANP (Global Air Navigation Plan): The Global Air Navigation Plan established by the ICAO to coordinate the advancement of aviation traffic services to enable member states to appropriately respond to future increases in aviation traffic.

[26] Resilience: The ability to maintain safety and air navigation services while responding to and adapting to emergencies quickly and efficiently and restoring normal operations.

[27] NextGen (Next Generation Air Transportation System): A program to enhance the US airspace system, promoted by the FAA.

[28] SESAR (Single European Sky ATM Research): A series of programs to define, develop, and deploy technologies necessary for the transformation of European air traffic management, jointly promoted by the EU (EASA) and EUROCONTROL.

[29] APAC ANP (Asia Pacific Air Navigation Plan): An air traffic plan for the Asia-Pacific region that serves as a bridge between the Global Air Navigation Plan (GANP) and the plans of individual countries. It was revised to its current structure following a decision by the ICAO Council in June 2014.

[30] FF-ICE –The Flight and Flow Information for a Collaborative Environment (FF-ICE) is a concept developed by ICAO to facilitate the sharing of a richer set of information among all stakeholders that are involved in a flight. FF-ICE is considered a key enabler of the future Trajectory Based Operations (TBO) environment. The concept has been broken down into the following two components for further exploration.
- Release 1 (R1) – Focuses on the services that exchange pre-departure information
- Release 2 (R2) – Focuses on the services that exchange post-departure information

frameworks. Additionally, the APAC TBO Pathfinder Project[31] was launched in 2024 with the participation of 10 countries, to include Japan, the United States, China, and Singapore.

On the other hand, in recent years, many regions are facing ongoing conflicts, and geopolitical risks have increased due to the instability in the international affairs. Under such circumstances, it is essential to collaborate with other countries to improve the air traffic environment so that international airlines can not only transport passengers but also reliably support Japan's supply chains.

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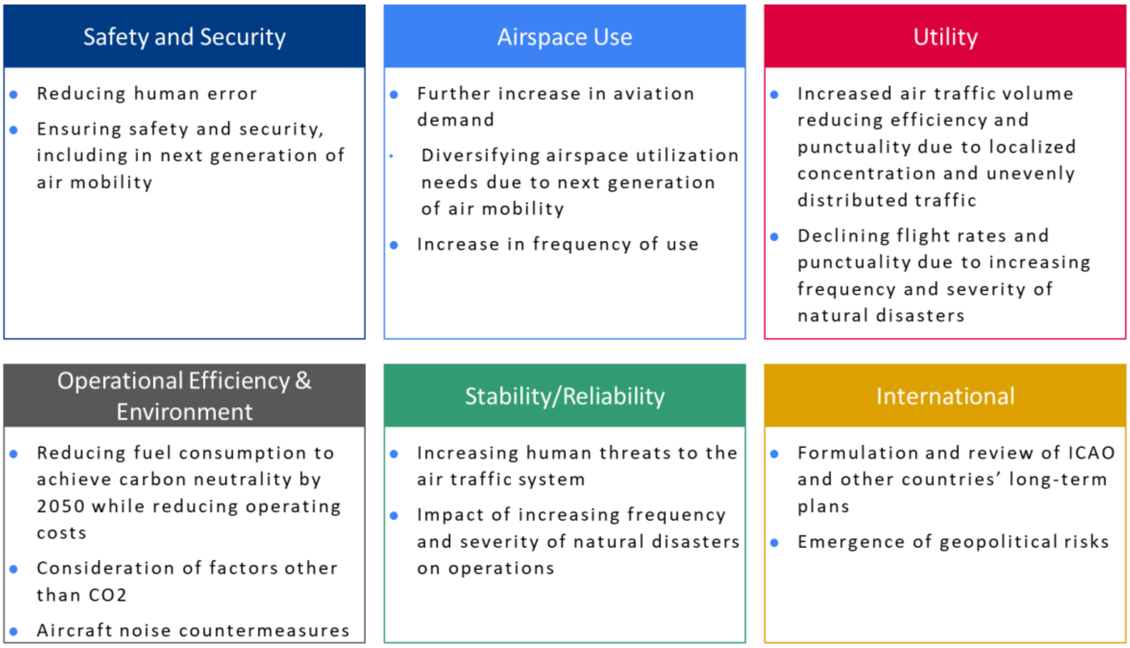
[31] APAC TBO Pathfinder Project: A project to strengthen cooperation among air traffic control units in the Asia-Pacific region, build a common understanding, and promote the evaluation and demonstration of the benefits of TBO, as well as the creation of a roadmap for its implementation, with the aim of realizing TBO.

(3) Necessity of revising CARATS

Based on the progress of previous initiatives and recent operational environment changes, revision to CARATS will be revised to address current and anticipated challenges (Figure 1-19).

Figure 1-19 Major Issues Surrounding CARATS



Safety and Security

- Reducing human error
- Ensuring safety and security, including in next generation of air mobility

Airspace Use

- Further increase in aviation demand
- Diversifying airspace utilization needs due to next generation of air mobility
- Increase in frequency of use

Utility

- Increased air traffic volume reducing efficiency and punctuality due to localized concentration and unevenly distributed traffic
- Declining flight rates and punctuality due to increasing frequency and severity of natural disasters

Operational Efficiency & Environment

- Reducing fuel consumption to achieve carbon neutrality by 2050 while reducing operating costs
- Consideration of factors other than CO2
- Aircraft noise countermeasures

Stability/Reliability

- Increasing human threats to the air traffic system
- Impact of increasing frequency and severity of natural disasters on operations

International

- Formulation and review of ICAO and other countries' long-term plans
- Emergence of geopolitical risks

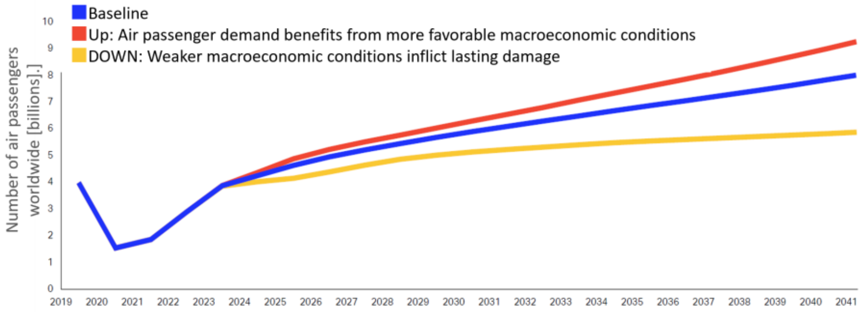
2. Vision for the future

CARATS2040 Vision for the Future

In the aviation field, ensuring safety and security is the top priority. So, we will utilize digital technologies such as application of AI technologies to prevent miscommunication between air traffic controllers and pilots, improve the detection accuracy of airport surveillance systems, while optimizing and streamlining overall air traffic control. By reducing the risk of human error, we aim to minimize aviation accidents and serious incidents caused by air navigation services.

At the same time, by 2040, global aviation demand is projected to double compared to 2019 levels, while Japan's aviation demand is expected to increase by approximately 1.5 times compared to 2019 demand level (Figures 2-1 and 2-2).To address this demand and further enhance aviation convenience, it is aim of CARATS2040 that the current air traffic control operations—centered on traffic flow control measures such as airspace-segmented control instructions and departure holding—will be transformed into a 4D trajectory[32]-based operations that manages the trajectories of all aircraft in all flight phases from departure to arrival in a time-based manner. In this process, various operational requirements (flight intent such as flight purpose, route, altitude, etc.) and detailed weather information related to the operation of existing aircraft and next generation air mobility will be shared in real time among air traffic control, aircraft operators, airport companies, and other flight relevant parties. Ultimately, air traffic control units and operators will flexibly select efficient routes, altitudes, and other parameters, coordinate aircraft trajectories, and achieve smooth and efficient operations (Figure 2-3) based on this 4D trajectory-based operational information-sharing construct.

Figure 2-1 Global Air Travel Demand Forecast (Number of Passengers)



Source：Global Outlook for Air Transport(December 2023,IATA)

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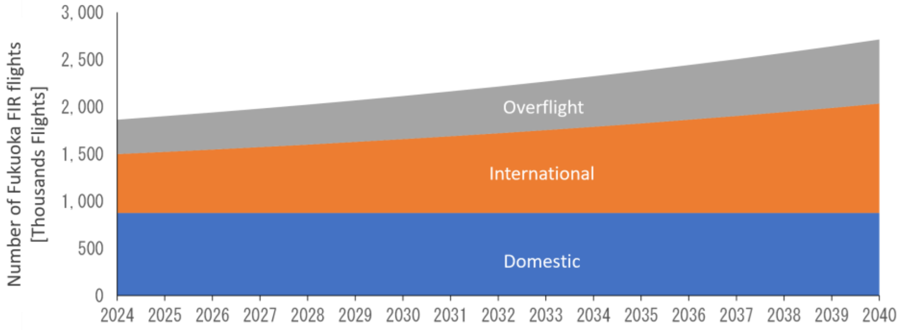
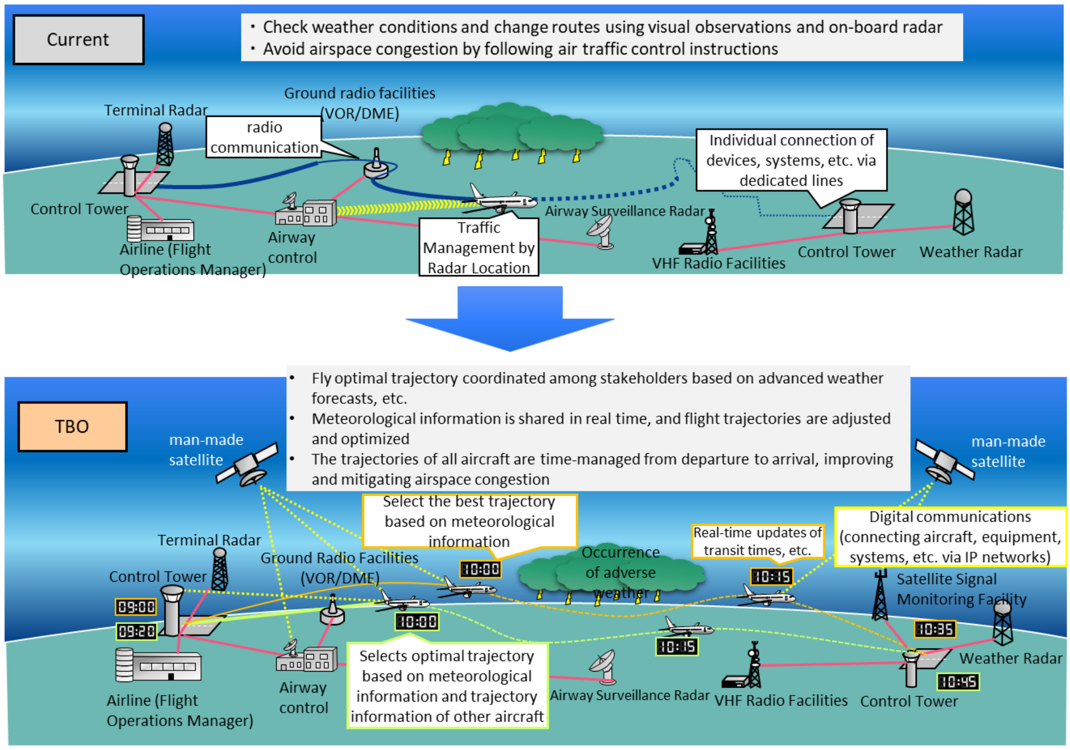
[32] 4-dimensional trajectory: A trajectory that adds time to the 3-dimensional position information of an aircraft.

Figure 2-2 Air Transport Demand Forecast (Number of Flights) in Japan (Fukuoka FIR)



Note: Based on「Global Outlook for Air Transport」 (June 2024,IATA)and estimate by using sing the growth rate on「Post-COVID-19 Forecasts Scenarios -COVID-19 IMPACT ON THE ICAO LONG-TERM TRAFFIC FORECATS-」(January, 2024)

Figure 2-3 Achieving TBO



Current

- Check weather conditions and change routes using visual observations and on-board radar
- Avoid airspace congestion by following air traffic control instructions

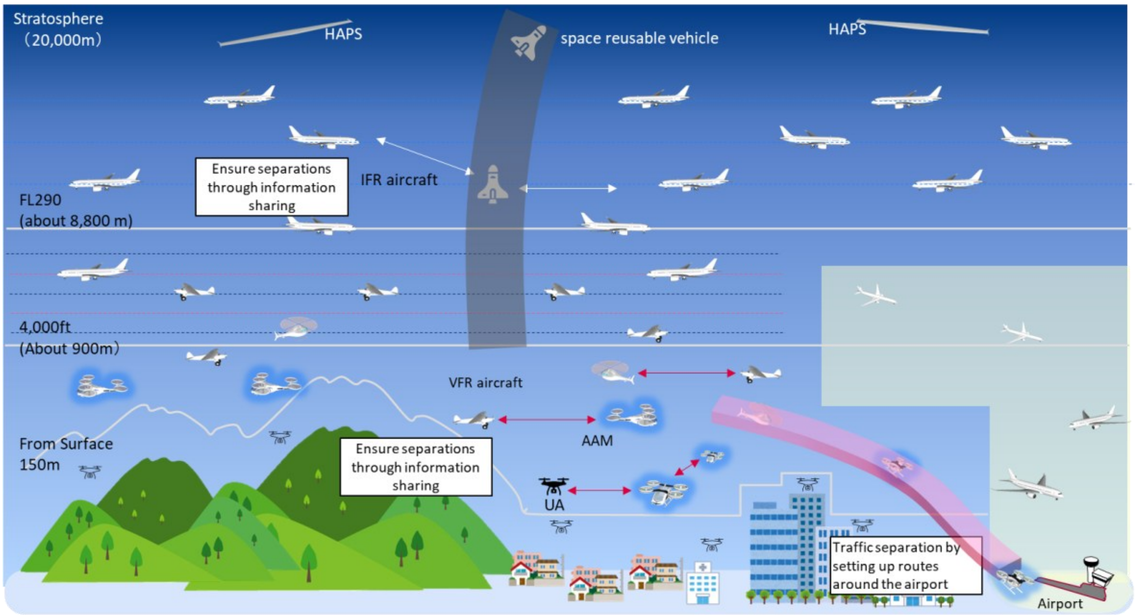
TBO

- Fly optimal trajectory coordinated among stakeholders based on advanced weather forecasts, etc.
- Meteorological information is shared in real time, and flight trajectories are adjusted and optimized
- The trajectories of all aircraft are time-managed from departure to arrival, improving and mitigating airspace congestion

Additionally, the expansion of next generation air mobility and advancements in operational technology are expected to increase the density and frequency of use in both low-altitude and high-altitude airspace, potentially transforming the skyline. In low-altitude airspace, unmanned aircraft are expected to play a significant role in tasks such as inspections in areas where visual confirmation is difficult or at high elevations, in rapid situation assessment during disasters, and as a convenient and everyday means of transport for small-scale cargo delivery. Furthermore, advanced air mobility is anticipated to emerge as alternative transportation options for areas with geographical constraints or challenges, such as mountainous regions, and as urban air taxis.

In high-altitude airspace, HAPS and space reusable vehicles are also expected to be commercialized. Therefore, efforts will be made to achieve safe and efficient air traffic through airspace management tailored to the flight characteristics of aviation mobility and the type of airspace, as well as the development and improvement of CNS required for remote operation and automated/autonomous navigation (Figure 2-4).

Figure 2-4 Safe and efficient operation of diverse air mobilities



Furthermore, based on the target set in the Global Warming Countermeasures Plan developed in 2021in which the Japanese Government aims to reduce CO2 emissions by 46% from 2013 levels by fiscal year 2030, we will reduce CO2 emissions per unit of transport by approximately 16% through improvements in aircraft performance and operational efficiency, with the goal of achieving carbon neutrality by 2050.

In addition, we will work to reduce aircraft noise with the understanding and cooperation of local communities.

Regarding CNS, technology infrastructure supporting air traffic systems, we will enhance resilience by securing alternative support measures. We will also strengthen the robustness and redundancy of air traffic systems to prepare for unforeseen circumstances such as natural disasters, system failures, and cyberattacks. Furthermore, we will aim to minimize impact on operations and achieve early restoration of operations through rapid information sharing among relevant parties using digital technology.

In addition, we will strengthen cooperation with foreign air traffic control facilities and other organizations, leading international discussions contributing to the development of international air traffic.

3. Setting of targets and indicators

CARATS2040 Setting of targets and indicators

To realize the aforementioned vision for the future, we have set targets in the following six areas and established various indicators to objectively assess progress toward achieving each target (Figure 3-1). Additionally, we will conduct not only quantitative evaluations based on these indicators, but also qualitative evaluations of each target and will review the indicators themselves as necessary.

Figure 3-1 Examples of Goals and Indicators

Year of baseline: 2024, Target year: 2040

Region	Goals	Indicator Example
①Safety and security	Reduce the occurrence of aviation accidents caused by air navigation service [Zero aviation accidents caused by air navigation service, 50% reduction in serious incidents][*1]	- Number of aviation accidents, serious incidents, and incidents below that level - Number of preventive measures taken under SMS
②Use of Airspace	Achieving advanced utilization of airspace and expanding airspace capacity [Approximately 3 million aircraft per year][*2]	- Number of aircraft that can be handled by air traffic control
③Utility	Improving convenience for operators and passengers	- Punctuality - Service rate
④Operational Efficiency and the Environment	Achieving greater operational efficiency and implementing global warming countermeasures [Operational improvements reduce fuel consumption and CO2 emissions by 6%][*3]	- Fuel consumption - CO2 emissions
⑤Stability / reliability	Providing stable control services even during disasters, minimizing impact on flights	- Number of incidents affecting flight operations due to air traffic system failures - Number of countermeasures taken
⑥International	Contributing to the development of international air traffic	- Number of contributions to international conferences - Number of contributions to international technical cooperation

* 1: In line with the ICAO GANP's goal of zero aviation accidents and a 50% reduction in serious incidents, Japan has adopted the same objectives.

* 2: It is projected that aviation demand will increase by approximately 1.5 times by 2040. Assuming that Japan's annual aircraft handling capacity will be approximately 2 million aircraft in 2024, the handling capacity will also be increased by 1.5 times to approximately 3 million aircraft per year to align with the expected demand growth.

* 3: Taking into account our country's goal of reducing CO2 emissions by 10% through operational improvements by 2050, the CO2 reduction target for 2040 has been set at 6%.

4. Future Direction of Initiatives

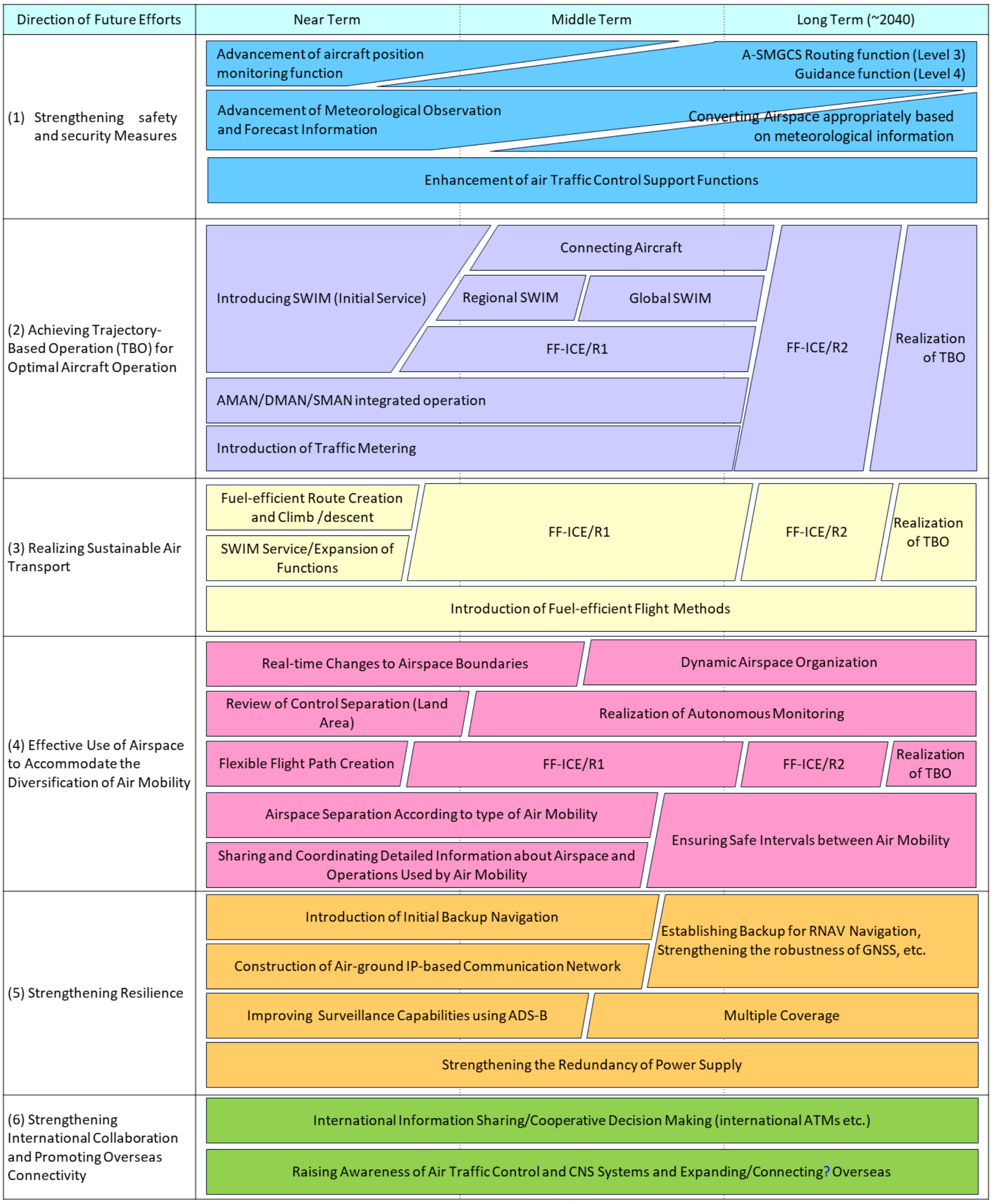
4. Future Direction of Initiatives

To achieve air traffic system renovation with the above goals, we will implement various measures in line with the following six initiatives (Figures 4-1 and 4-2).

Figure 4-1 Direction of Future Efforts

Direction of Future Efforts	Overview of Future Initiatives
1. Strengthening Safety and Security Measures	• Monitoring and detecting dangerous situations using image and voice recognition technology • Mutual awareness among aircraft using ADS-B • Safety measures considering next generation air mobility
2. Achieving Trajectory-Based Operations (TBO) for Optimal Aircraft Performance	• Transition to time management operation • Pre-flight and real-time trajectory adjustment
3. Realizing Sustainable Air Transport	• Introduction of fuel-efficient flight methods • Operational improvements based on decarbonization promotion plan
4. Effective use of Airspace to Accommodate the Diversification of Air Mobility	• Expanding airspace capacity by optimizing air traffic control resource allocation • Flexible route-setting to meet operator needs • Establishment of operational rules that consider the characteristics of new (advanced?) air mobility
5. Strengthening Resilience	• Strengthening CNS resilience • Early recovery through expedited information sharing after an incident occurs
6. Strengthening International Collaboration and Promoting Overseas	• International traffic flow management and realization of TBO • Overseas deployment of air traffic control and CNS systems

Figure 4-2 Outlook for Future Initiatives



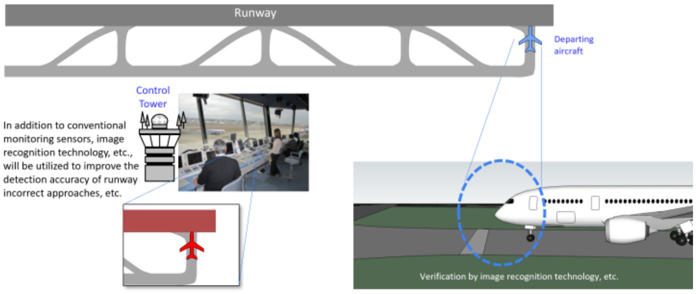
(1) Strengthening Safety and Security Measures

(Related Targets ①, ②, ⑤)

By strengthening safety and security measures in the field of air traffic, we will minimize the risk of aviation accidents and other incidents involving air navigation services.

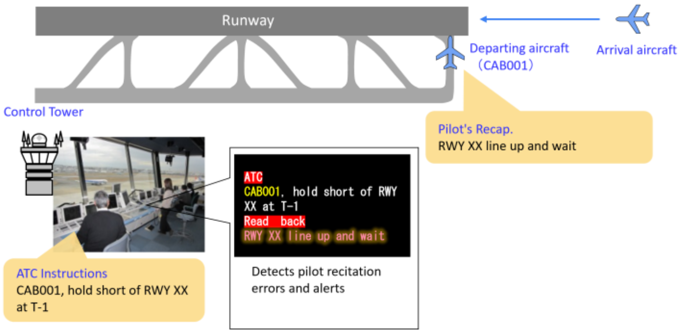
On the air traffic control side, we will advance the development and introduction of digital towers[33] from the perspective of strengthening external monitoring and improve the accuracy and reliability of airport surveillance systems through ADS-B[34] and image recognition technology (Figure 4-3). Additionally, we will develop and introduce air traffic control support systems that detect and warn of dangerous situations caused by misunderstandings between air traffic controllers and pilots through the use of voice recognition technology (Figure 4-4).

Figure 4-3 Utilization of image recognition technology



In addition to conventional monitoring sensors, image recognition technology, etc., will be utilized to improve the detection accuracy of runway incorrect approaches, etc.

Figure 4-4 Utilization of voice recognition technology



Pilot's Recap.
RWY XX line up and wait

ATC Instructions
CAB001, hold short of RWY XX at T-1

Detects pilot recitation errors and alerts

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[33] Digital Tower: A method of air traffic control utilizing digital technology, which not only provides remote air navigation services (remote tower) but also aims to improve visibility in blind area of the control tower and provide backup in case of emergencies such as disaster to the control tower.

[34] ADS-B (Automatic Dependent Surveillance-Broadcast): A function that automatically and periodically transmits and receives basic dynamic information (position, speed, etc.) of aircraft.

For flight operations, mutual awareness among between aircraft using ADS-B-enabled onboard devices enables the detection of surrounding aircraft, thereby reducing the risk of aircraft collisions. Furthermore, in-flight meteorological observation and prediction information, such as turbulence and lightning, will be expanded and enhanced to improve operational safety and efficiency.

Additionally, both control and aircraft sides will consider the practical application of runway incursion detection systems (SURF-A[35], etc.), and optimizing and organizing overall air traffic to reduce congestion and convergence of arriving and departing aircraft, thereby reducing the risk of collisions on runways (Figure 4-5).Furthermore, the introduction of A-SMGCS[36] will enable safe and efficient ground movement of aircraft based on automatic guidance using aeronautical lights and other systems (Figure 4-6).

Figure 4-5 SURF-A

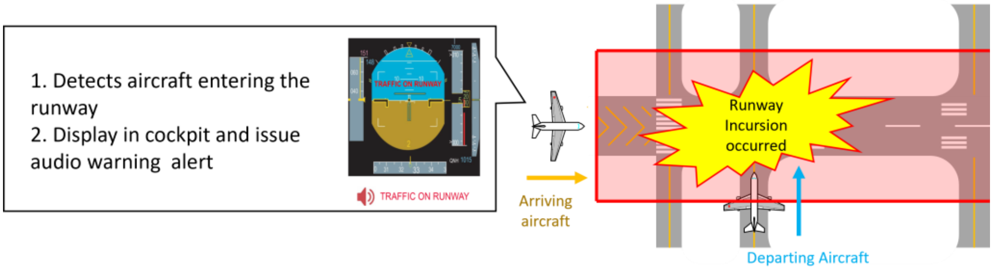
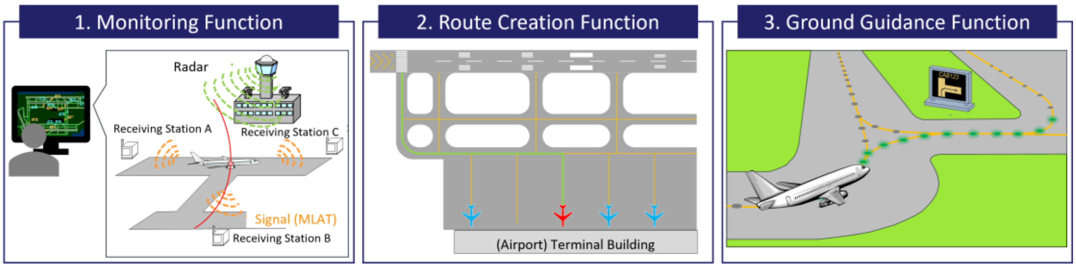


Figure 4-6 A-SMGCS



Meanwhile, regarding the next generation of advanced air mobility such as "air taxis", we will advance efforts to establish the necessary technical requirements and operational rules for ensuring safety in traffic management, while considering technological development and international trends, with the aim of creating an environment conducive to operational implementation.

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[35] SURF-A (Surface Alerting): An airborne function that issues warnings to prevent collisions on runways using ADS-B.

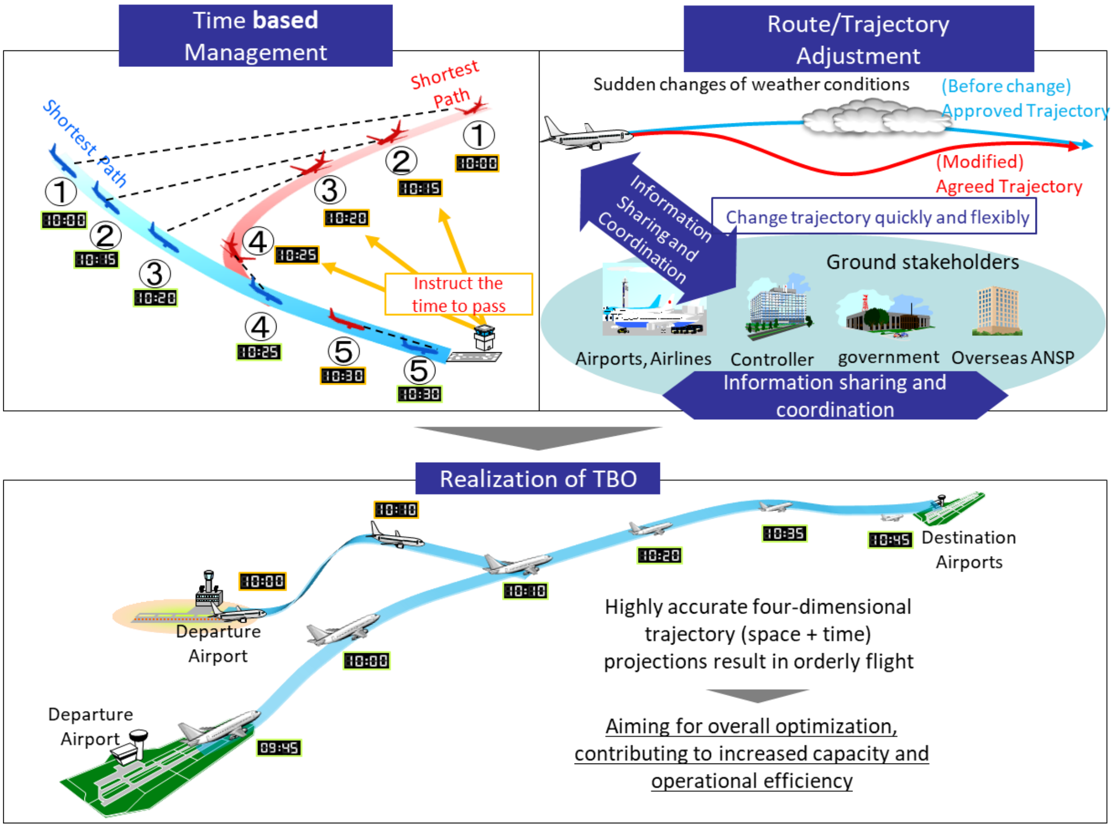
[36] A-SMGCS (Advanced Surface Movement Guidance and Control System): A system composed of surveillance functions, routing functions, and guidance functions to ensure safety and maintain airport capacity under all weather conditions

(2) Realization of trajectory-based operations (TBO) for optimal aircraft operations

(Related targets: ②, ③, ④)

For full TBO implementation, aircraft time-based management and aircraft trajectory negotiations are achieved through a step-by-step process. (Figure 4-7).

Figure 4-7 TBO Concept



First, conventional airspace-based operations, which primarily involves setting independent separation for each traditional airspace, will be transitioned to time based management operations that strategically and integrally manage the departure times, times of passage through specific points, and subsequent arrival times of all aircraft(Figure 4-8).To achieve this, we will advance the operational integration of AMAN/DMAN/SMAN, which adjust the runway usage priority and timing of departing and arriving aircraft, in addition to metering[37] to manage the timing of aircraft passing specific points along air routes.

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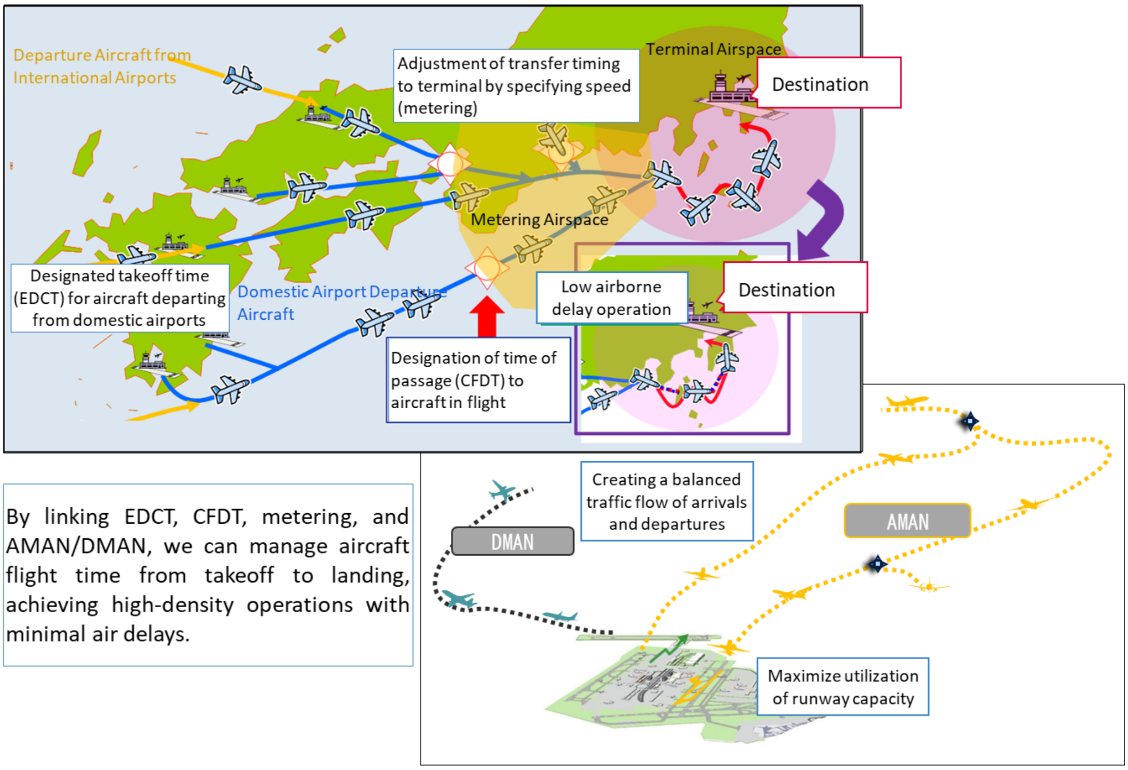
[37] Metering: An air traffic control technique that sets the spacing between aircraft by managing the time of passage at specific points along the flight path.

Figure 4-8 Time Based Management Operations as an Initial Step Towards TBO



By linking EDCT, CFDT, metering, and AMAN/DMAN, we can manage aircraft flight time from takeoff to landing, achieving high-density operations with minimal air delays.

Next, we will implement pre-flight trajectory negotiations. Specifically, flight information, aeronautical information, meteorological information, airspace congestion status, and other data will be shared digitally among relevant parties. Based on this information, air traffic controllers and operators will make highly accurate assessments and decisions during the pre-flight flight planning phase. By adjusting flight altitudes, and phase-specific flight times, we will achieve high-density operations with minimal air delays. In particular, flight schedule information is essential for maximizing the effectiveness of TBO, so operators must share accurate information with air traffic control units in a timely and appropriate manner.

Subsequently, trajectory negotiations during flight operations will be coordinated real-time. Specifically, through the enhancement of air traffic control information processing systems and CNS systems, basic aircraft operational data will be shared with air traffic control units. Additionally, by sharing refined and advanced meteorological information and utilizing time based management techniques, swift and flexible responses to sudden changes in conditions such as the occurrence of severe weather during flight or the closure of runways at arrival airports will be enabled, thereby achieving optimal aircraft operations.

(3) Realization of sustainable air transport

(Related target: ④)

In recent years, reducing CO2 emissions has been recognized as a major global initiative, such that the 2022 ICAO Assembly adopted a long-term decarbonization goal (LTAG) aimed at achieving carbon neutral by 2050 was adopted. Under this scenario, the goal is to reduce CO2 emissions by 4–11% by 2050 compared to 2019 levels through improvements in aircraft operations.

In response to the growing demand for decarbonization, Japan will also promote decarbonization in the aviation sector and achieve sustainable air transport. Specifically, we will promote the advancement of traffic flow control, expand introduction of approach procedures such as RNP to ILS[38], RNP-AR, and LP/LPV, and drive improvements in aircraft performance. Additionally, we will adopt and enhance application of CDO[39], implement free routing in upper airspaces[40], and achieve TBO to attain 6% CO2 emissions reduction by 2040 (Figures 4-9 and 4-10).

In addition, operators will take the initiative in promoting operational improvements based on decarbonization promotion plans and other sustainability measures.
Furthermore, considering that nitrogen oxides (NOx), sulfur oxides (SOx), and contrails have been pointed out as having the potential to contribute to global warming, we take will work to reduce environmental impact through measures such as efficient route setting and operational method improvements. These measures also address other environmental factors such as noise pollution.

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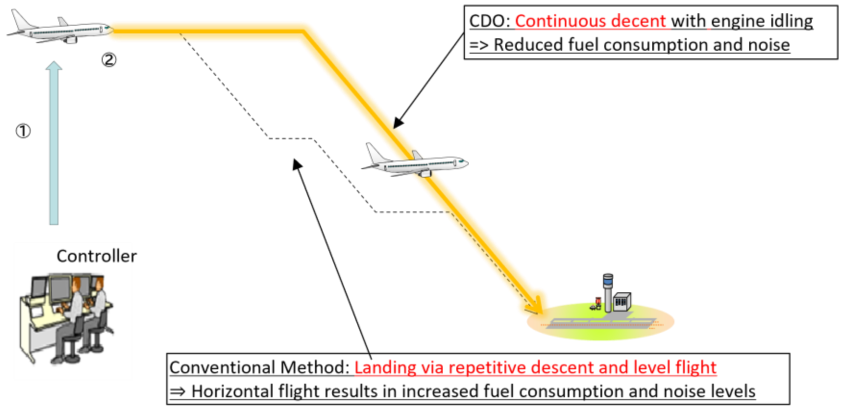
[38] RNP to ILS approach procedure (Required Navigation Performance to Instrument Landing System): A procedure that combines the ILS approach procedure with a curved route using RF (Radius to Fix) legs to avoid obstacles and enable route shortening.

[39] CDO (Continuous Descent Operation): An operational procedure in which an arriving aircraft descends continuously from the optimum top of descent to the commencement of the instrument approach, using an optimal descent rate.

[40] free routing in upper airspaces: Measures to enable the setting of flight paths at the discretion of operators, rather than fixed routes announced in advance, in airspace above a certain altitude.

Figure 4-9 Advancement of CDO Through Data Link

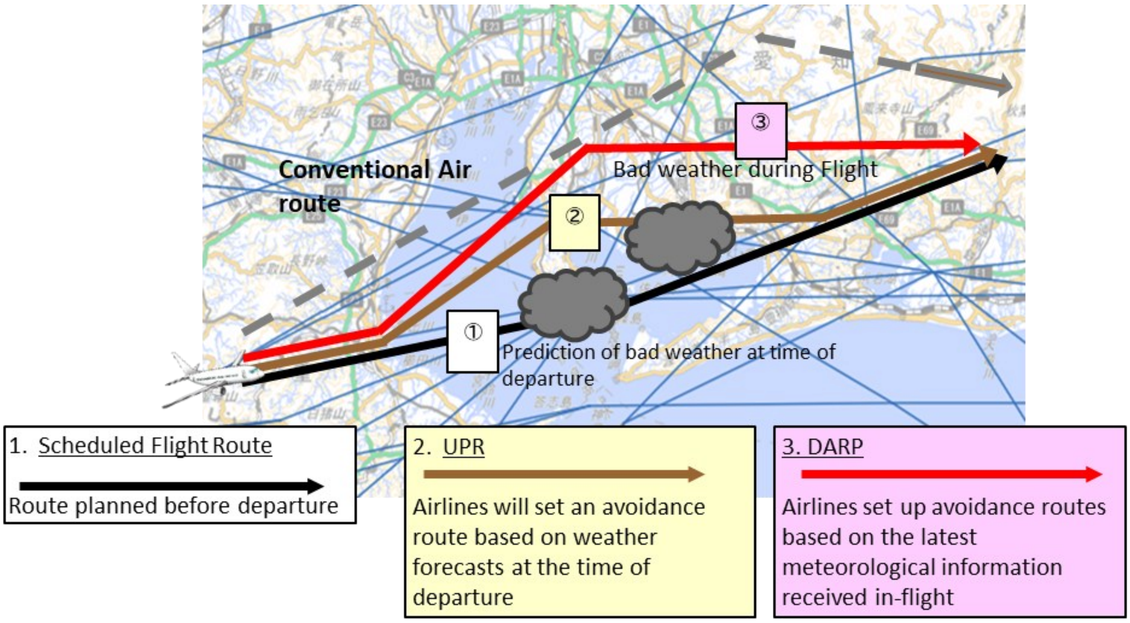
(1) The controller sends relevant data (trajectory information) necessary for CDO (Continuous Descent Operations at Optimal Descent Rate) to the pilot.
(2) The pilot inputs the data in the aircraft system and continues descending at the optimal descent rate.



CDO: Continuous decent with engine idling
=> Reduced fuel consumption and noise

Conventional Method: Landing via repetitive descent and level flight
⇒ Horizontal flight results in increased fuel consumption and noise levels

Figure 4-10 Free routing at Upper airspace



1. Scheduled Flight Route
Route planned before departure

2. UPR
Airlines will set an avoidance route based on weather forecasts at the time of departure

3. DARP
Airlines set up avoidance routes based on the latest meteorological information received in-flight

---

[41] A flight plan method in which the aircraft operator creates a preferred flight route prior to departure, taking into account aircraft performance, flight schedule, forecast meteorological conditions, etc.

[42] DARP (Dynamic Airborne Reroute Procedure): An operational procedure in which the flight operations manager calculates the optimal new route for an aircraft in flight based on the latest meteorological conditions, etc., and issues route clearance by the air traffic control unit upon request from the aircraft.

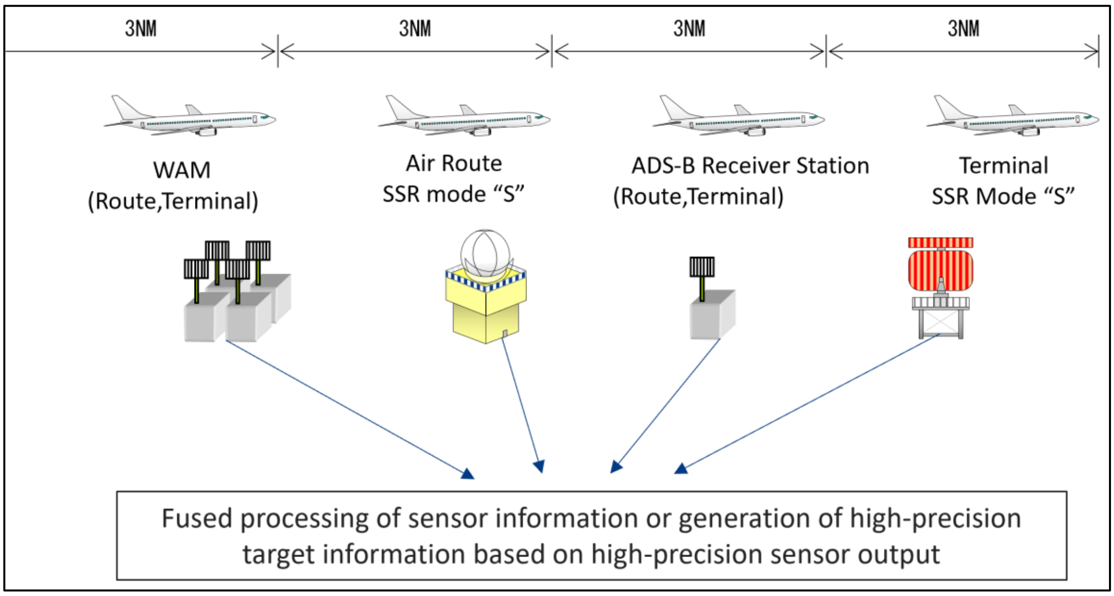
(4) Effective use of airspace that accommodates the diversification of air mobility

(Related targets: ①, ②, ④)

We will promote effective use of airspace while taking into account further increases in air traffic and the diversification of airspace utilization.

Specifically, we will optimize the allocation of ATC resources through dynamic changes in airspace configuration based on the volume and complexity of air traffic, reduce the workload of air traffic controllers and minimize separation by utilizing data links and other technologies, thereby improving operational efficiency and expanding airspace capacity (Figure 4-11).Additionally, by expanding the use of UPR (User Preferred Route) to allow operators to create arbitrary routes during flight planning in accordance with their needs, and DARP (Dynamic Airborne Reroute Procedure) to enable flexible route changes after departure, we will increase opportunities for aircraft to fly optimal routes and altitudes, thereby improving operational efficiency. Furthermore, in coordination with relevant government agencies, we will secure the necessary frequencies for the operation of next generation air mobility services.

Figure 4-11 Minimizing Control Separation

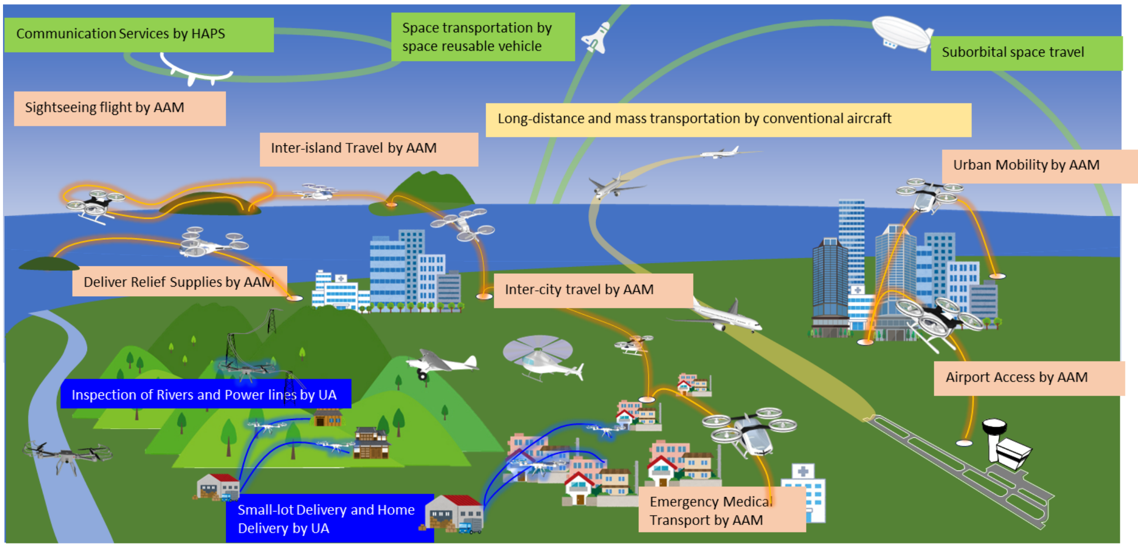


Furthermore, in anticipation of further airspace diversification resulting from next generation of air mobility, we aim to achieve airspace usage that can balance safety and efficiency by taking into account the characteristics of both existing aircraft and next generation of air mobility (Figure 4-12). At that time, we will establish appropriate equipment requirements, operational methods, and operational rules for the next generation of air mobility, taking into consideration technological development and international trends, while giving due consideration to social acceptability and safety.

In the short term, we will introduce operations that segregate the airspace used for each type of air mobility based on risk assessments for each airspace. In the medium to long term, we will transition to integrated airspace operations by ensuring appropriate safety spacing between existing aircraft and next generation air mobility.

Additionally, to achieve efficient air traffic management across the entire airspace, we will enhance the functionality and expand the services of the information-sharing platform (SWIM) to facilitate the integration and coordination of the airspace used by each type of air mobility and various operational preference (flight intent), among stakeholders and local communities.

Figure 4-12 Coexistence of existing aircraft and next generation of air mobility



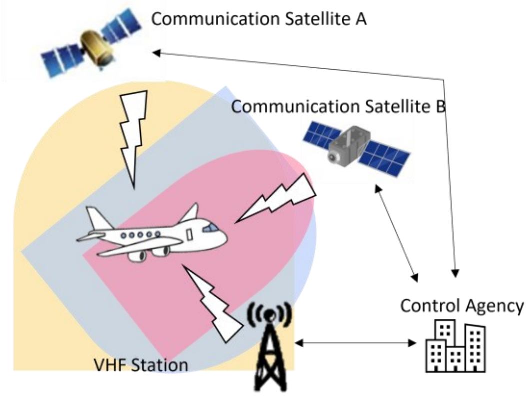
(5) Strengthening resilience

（related targets: ①, ③, ⑤）

By enhancing the robustness and redundancy of air traffic systems, we will mitigate the impact on operations caused by unforeseen events such as natural disasters, system failures, and cyberattacks. In particular, we aim to enhance the resilience of CNS, the technology infrastructure of Japan’s air traffic management system.

With regard to communication, enabling multi-link via various communication media could prevent communication interruptions when switching media and ensure the continuity of air navigation services even in the event of a specific communication media failure (Figure 4-13).

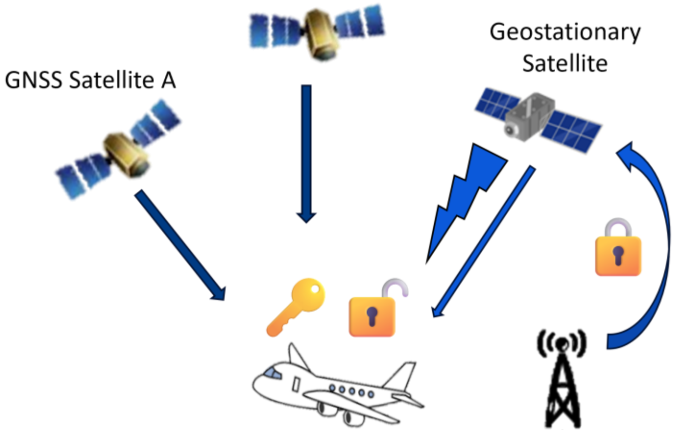
Figure 4-13 Strengthening Communications Resilience



Communications: Multiple communication media (satellite and ground facilities)

With regard to navigation, we will ensure redundancy of GNSS and utilized frequencies, introduce message authentication technology, and monitor radio wave conditions to minimize the impact of ionospheric storms, jamming, and spoofing on satellite navigation. Additionally, we will ensure the continuity of operations by minimizing navigation utilizing conventional navigation facilities. (Figure 4-14).

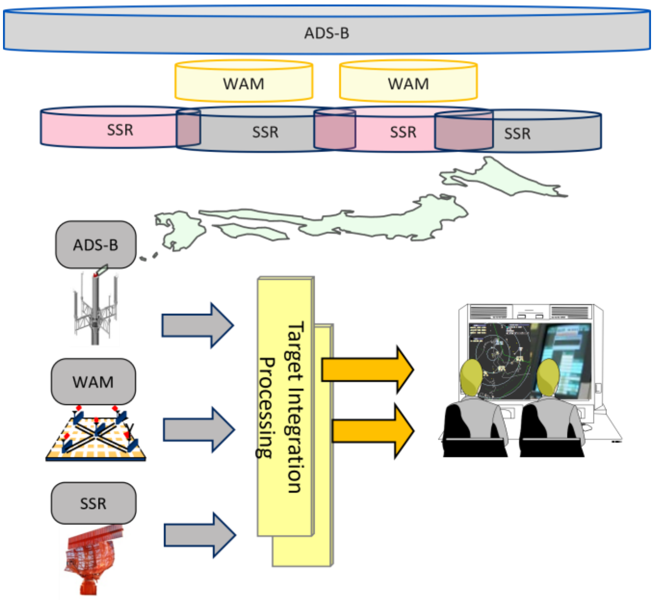
Figure 4-14 Strengthening Navigation Resilience



Navigation: GNSS and frequency redundancy/signal authentication technologies

For surveillance, multiple surveillance sensors (SSR[43], WAM[44], ADS-B receivers, etc.) are combined to provide multiplex coverage, thereby enhance the intercompatibility and reliability of the surveillance system, minimizing the effects of jamming etc., to improve reliability (Figure 4-15).

Figure 4-15 Strengthening Surveillance Resilience



Surveillance: Multiplexing coverage with multiple surveillance sensors

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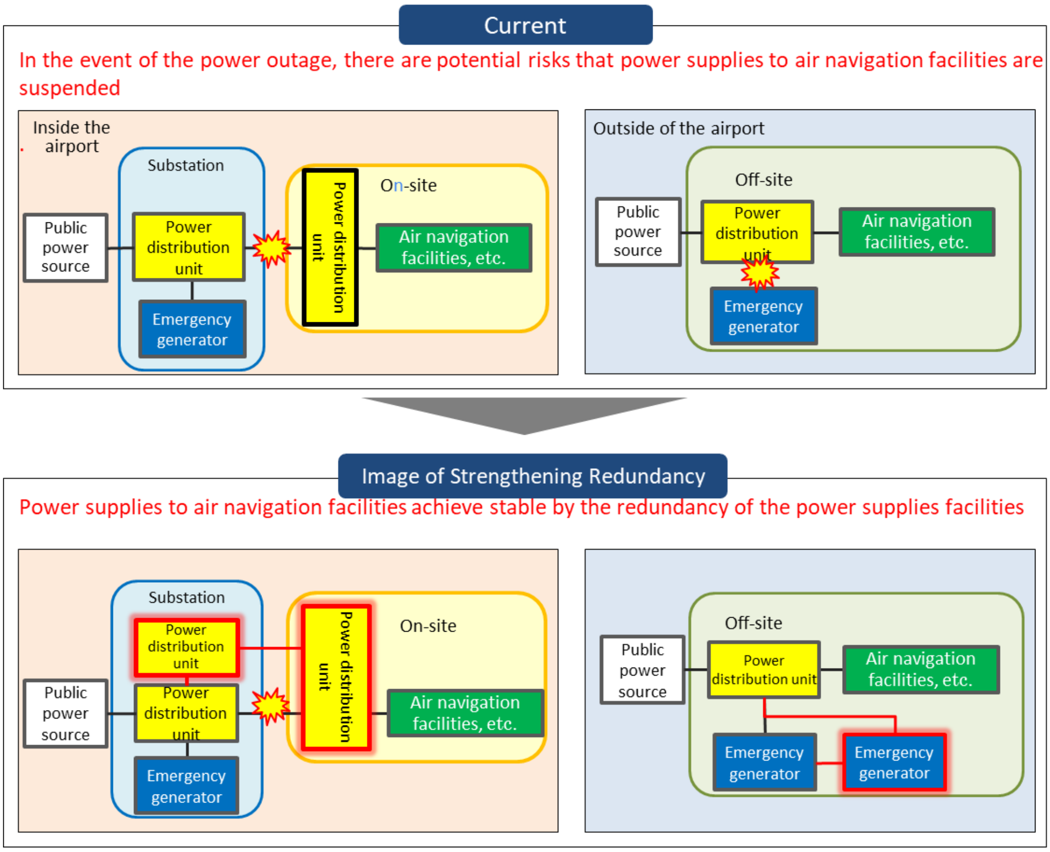
[43] SSR (Secondary Surveillance Radar): A ground-based radar facility that acquires information on aircraft identification, altitude, and position.

[44] WAM (Wide Area Multilateration): A system that monitors the positions of aircraft near an airport, including those in flight, by receiving signals transmitted from aircraft at multiple ground receiving stations and using the time difference in reception.

Additionally, the redundancy of power supply facilities supporting air navigation facilities will be strengthened to ensure the continuity of air traffic services in the event of the power outage (Figure 4-16).

Figure 4-16 Strengthening Redundancy in power Facilities



In the event of the power outage, there are potential risks that power supplies to air navigation facilities are suspended

Power supplies to air navigation facilities achieve stable by the redundancy of the power supplies facilities

With regard to airport operations, in order to enable real-time and smooth information sharing among multiple airport stakeholders supporting early respond and recovery following an incident, the expansion of airport CDM will be promoted with a view to future development of TAM[45]. Furthermore, by further integration between air traffic management and airport CDM, we will establish a coordinated decision-making framework among air traffic control units, airport operators, airlines, meteorological agencies, and other relevant parties to achieve effective use of airspace and safe, as well as efficient aircraft operations.

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[45] TAM (Total Airport Management): A system that integrates various events and information to be shared on the landside and airside into a single platform and manages them comprehensively to improve airport operational efficiency, punctuality, resilience, and environmental performance.

(6) Strengthening international cooperation and promoting overseas expansion

（Related targets：①、②、③、④、⑤、⑥）

As it is expected that demand for international flights will continue to grow, the importance of international cooperation in the aviation sector is becoming more important. Therefore, we will strengthen our participation in discussions at forums such as ICAO on international frameworks for the realization of TBO, Regional ATFM[46], and operation of next generation air mobility. This will enable us to strengthen air traffic management at the regional level, including air traffic flow management based on coordination with air traffic control units in neighboring countries, and also we will actively promote operational methods and demonstration projects with the aim of further advancing ATM globally while realizing TBO.

Additionally, in the event of an emergency such as flight restrictions or loss of airport functionality caused by international circumstances or natural disasters, rapid sharing of relevant information is required to ensure the stable provision of aviation services. To this end, a system for sharing information will be established between domestic and foreign operators and control agencies and foreign control agencies. Furthermore, to enhance cooperation with air traffic control facilities in neighboring Flight Information Regions (FIRs)[47], we will promote information exchange and technical cooperation (Figures 4-17 and 4-18).

Figure 4-17 Technical Cooperation for Training Air Traffic Control Technicians Overseas

Note: Navigation equipment maintenance technology will be passed on to overseas engineers

Figure 4-18 Construction of Radio Facilities Through Grant Aid

Note: Supporting radar installation at overseas airports

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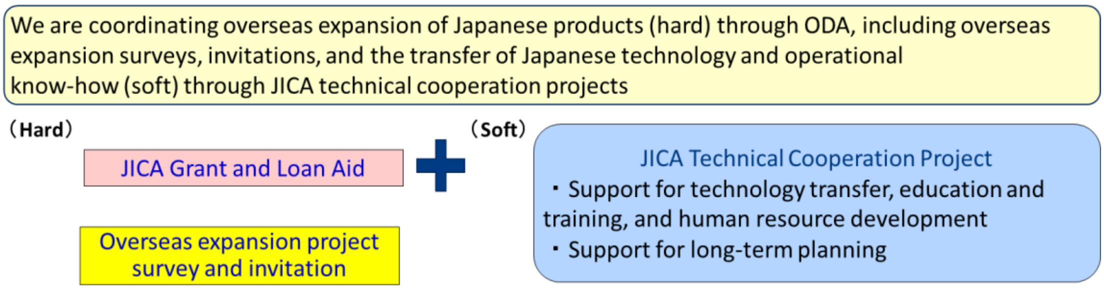
[46] In ICAO DOC9971, "Regional ATFM" refers to the collaborative application of ATFM principles and procedures across multiple States or ANSPs (Air Navigation Service Providers), enabling efficient management of air traffic flows that cross international boundaries or large areas of airspace.

[47] An airspace of defined dimensions within which flight information service and alerting service are provided. Designated by the ICAO,Japan is responsible for the Fukuoka FIR.

Through exchanges of opinions and collaboration with foreign air traffic control units, universities, research institutions, and other entities, we will identify the latest knowledge, trends in technological development, needs, and advance various policies in a manner consistent with international standards. Simultaneously, we will strengthen the dissemination of information overseas regarding Japan's initiatives related to CARATS, with the aim of enhancing our presence.

Finally, to expand Japan's air traffic control system and CNS system to the overseas, we will actively participate in the development of regulatory guidance and contribute to ICAO framework discourse, etc., to identify the strengths of Japan's technology, promote international standardization, and work to raise awareness overseas and develop sales channels abroad. (Figure 4-19).

Figure 4-19 Overseas Deployment of Systems



5. Future plan

(1) Roles and cooperation of aviation stackholders

In promoting future initiatives, it is important for industry, scholars and academic experts, and the government to partner and collaborate (Figure 5-1). The expected roles of each stakeholder are as follows.

① Operators, aviation-related manufacturers (industries))

Operators will consider the trends in the development and maintenance of air navigation facilities and other related infrastructure. Operators will also request domestic and international aviation-related manufacturers to develop and introduce the next-generation of aircraft on-board equipment for potential implementation.

Aviation-related manufacturers will consider the needs of operators and air traffic control, and work to develop and commercialize new technologies, consult in development of international standards, and strategically expand overseas operations to contributing to the development of international aviation transportation systems and the enhancement of technical standards.

② Universities and research institutions (academic partners)

Universities will expand the scope of research activities in the field of air transportation, and collaborate with operators, aviation-related manufacturers, air traffic control, and other entities to conduct comprehensive research. They will also focus on educating and training the next generation of professionals.

Research institutions will collaborate with universities and domestic and international aviation-related manufacturers to promote research and development projects aimed at societal implementation. Additionally, they will contribute to the establishment of international standards and resolving technical challenges by considering the needs of operators, aviation-related manufacturers, air traffic control, and other stakeholders, as well as aviation-related trends in other countries.

③ Japan Civil Aviation Bureau, relevant authorites and agencies (governments)

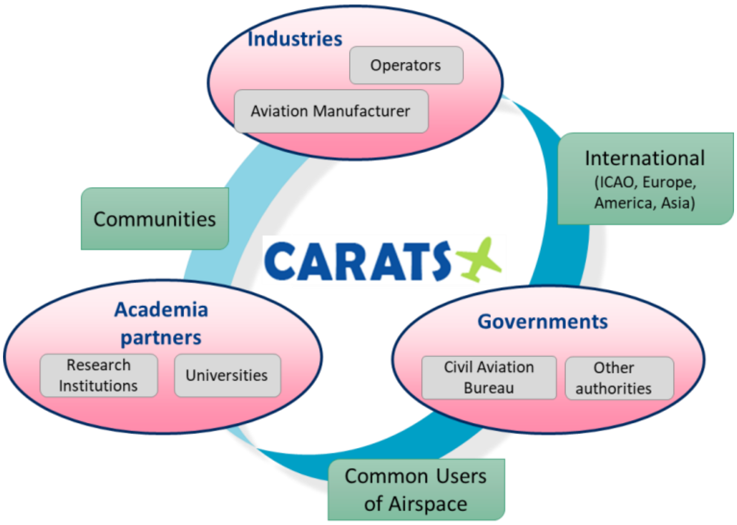
Japan Civil Aviation Bureau will systematically advance the development of air navigation facilities and infrastructure. When introducing new technologies or operational methods, JCAB will establish or revise relevant systems and standards as necessary. Additionally, JCAB will monitor the activities of overseas air traffic control units and aviation-related manufacturers, collaborate with relevant stakeholders to ensure overall consistency, and promote measures based on CARATS. Furthermore, JCAB will periodically measure, evaluate, and analyze effectiveness, conduct review of measures, and manage progress throughout.

Collaboration and cooperation will be enhanced among industry, academic partners, and government, centered on the Air Navigation Services Enhancement Center's ability, to expand, utilize, and analyze CARATS open data[48], enhance air navigation services, and develop and introduce new technologies and operational methods. Furthermore, JCAB will promote the utilization of government research and development funding systems, and support the activities of universities and research institutions, including human resource development and the next generation of community leaders.

The Air Navigation Services Enhancement Center (AEC, Fukuoka City, Fukuoka Pref.) was established in October 2024 to promote the enhancement of air navigation services. Taking future changes into account, such as the digitalization of information and the introduction of new technologies, the center is working with domestic and international stakeholders to promote the enhancement of air navigation services based air traffic data.

Furthermore, we will actively engage with the ICAO and other relevant organizations to establish international standards governing new technologies and operational methods, to include Trajectory Based Operations. Additionally, we will contribute to the development of international air traffic systems through providing technical support to the Asia-Pacific region and other areas.

Figure 5-1 Industry-Academia-Government Collaboration



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[48] CARATS Open Data: Open data provided by the Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism since 2015, consisting of flight track data based on actual operational data, text data in message format used for reporting airport weather observations and forecasts, and binary data from weather radar observations.

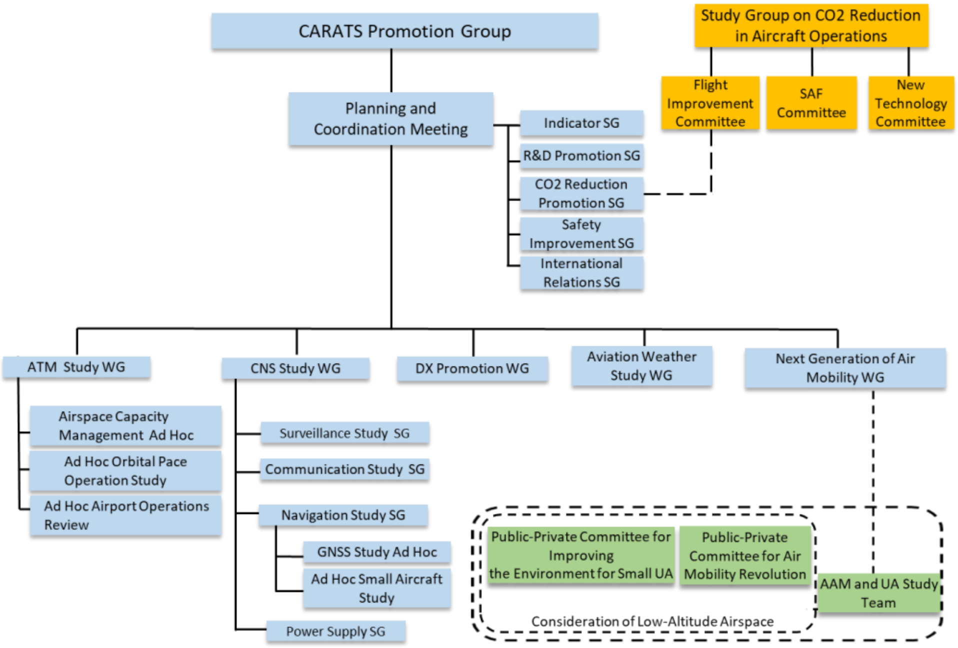
(2) Policy formulation, promotion, evaluation, and review

The Committee for Promoting Renovation of the Air Traffic Systems[49] has created a medium- to long-term roadmap (see attached documents) to promote each renovation measure in line with the future direction of initiatives.

Moving forward, the Committee for Promoting Renovation of the Air Traffic Systems will review the roadmap and direction of efforts made on its initiatives needed, based on the progress of each measure.

Additionally, under the Committee for Promoting Renovation of the Air Traffic Systems, the Planning and Coordination Meeting and Working Groups (WG) bring together stakeholders such as operators, aviation-related manufacturers, and research institutes. These groups comprehensively consider international trends and technological development to shape policy and promote collaborative efforts among industry, academic partners, and other governments. Within this framework, the SG regularly evaluates the effectiveness of policies based on various indicators. For policies deemed ineffective, the relevant WGs then analyze causes and consider revisions to or introduction of new policies as necessary. (Figure 5-2).

Figure 5-2 CARATS Promotion Structure



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[49] Committee for Promoting Renovation of the Air Traffic Systems： A council established to promote the systematic development of future air traffic systems based on CARATS through coordination among relevant parties, including academics, operators, research institutions, aviation-related manufacturers, and relevant government agencies such as the Civil Aviation Bureau

Closing Remarks

The air traffic system is an extremely complex system supported by many stakeholders, including operators and air traffic controllers. To date, the air traffic system has steadily advanced in response to increase of traffic volume and demand for improved safety and the increase of traffic volume. Today, however, the aviation industry is facing an unprecedented period of transformation. This is due to various factors, including the growing societal demand for decarbonization in the wake of the COVID-19 pandemic, the emergence of new airspace users such as drones and flying cars, and the rapid advancement of digital technologies such as those derived from AI. At the same time, the environment surrounding aviation systems is undergoing rapid and unpredictable changes, as evidenced by the instability in international affairs. In order to appropriately adapt to these changing trends, we have formulated CARATS2040 as a new vision with a target implementation year of 2040. In formulating this vision, the Committee for Promoting Renovation of the Air Traffic System held seven discussions over approximately one year, and the working groups and other bodies under the council held approximately 60 meetings towards deepened discussions on each area of responsibility.

CARATS2040 is the culmination of these discussions and efforts. The brilliance of CARATS2040 will illuminate the future of aviation and will continue to grow through constant refinement.

Going forward, we will promote research and development and social implementation of innovations in air traffic systems, establishing new guidelines for industry, academic partners, and government collaboration. Additionally, as needed, the overall policies and specific plans of CARATS2040 remain flexible to continuous review and necessary updates. While doing so, we will gather insights from a wide range of experts across industry, academia partners, and government, leveraging stakeholders to facilitate the expansion of initiatives, while prioritizing public relations efforts to foster critical national understanding.

In this way, through promoting the new technologies and operational methods proposed in CARATS2040, and by working to build consensus throughout the entire process via research and development to social implementation, we will develop an air traffic system that provides better services for operators, aviation-related manufacturers, users, and others.

Finally, we hope that these efforts to develop innovative air traffic systems will lead to effective social transformation and sustainable development.

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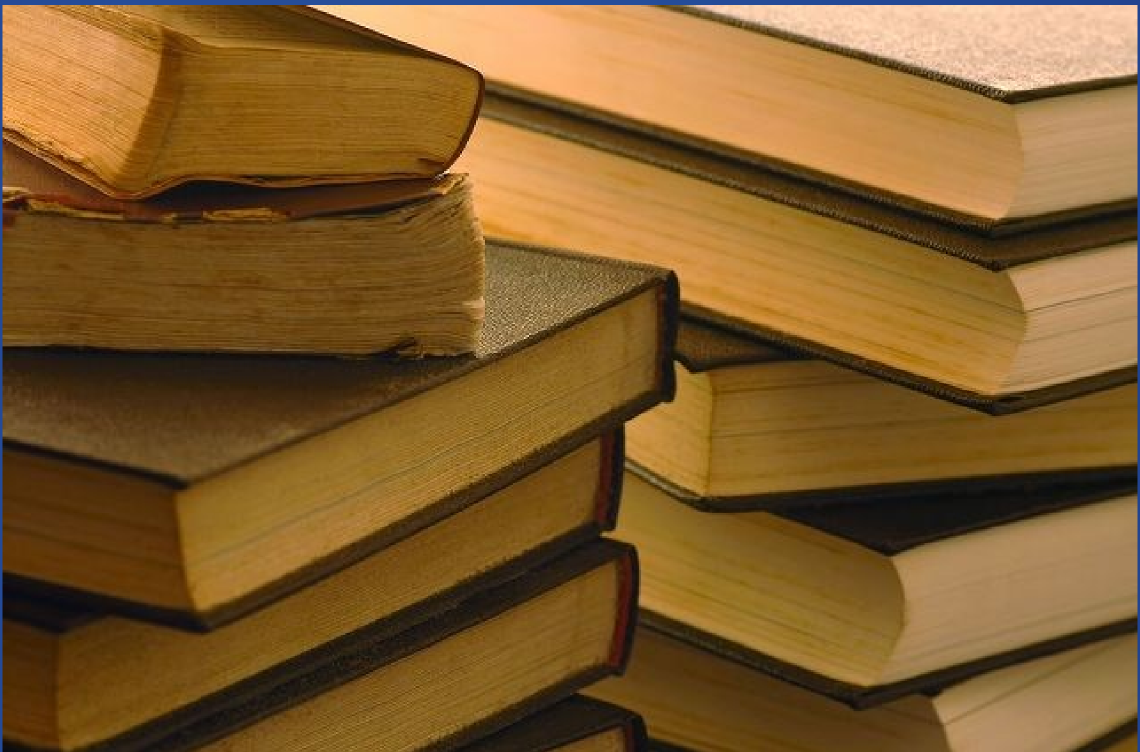
References



Meeting Agendas

March 5, 2024　　15th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Status of CARATS measures and challenges of　Japan's air traffic system
- International trends surrounding air traffic systems
- Future steps toward revising CARATS

April 30, 2024　　16th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Progress and challenges of CARATS
- Relevant industries etc. interviews
- Exchange of opinions

June 27, 2024　　17th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Analysis and evaluation of the achievement of CARATS policy objectives
- Current status, challenges, and direction for review of CARATS

August 7, 2024　　18th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Review outline of CARATS
- Reports from CARATS SG/WG

November 26, 2024　　19th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Drafting of CARATS 2040 text

March 18, 2025　　20th Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Drafting of CARATS 2040 text
- Drafting of roadmap for CARATS 2040

June 18, 2025　　21st Meeting of Committee for Promoting Renovation of the Air Traffic Systems

- Drafting of CARATS 2040 text
- Drafting of roadmap for CARATS 2040

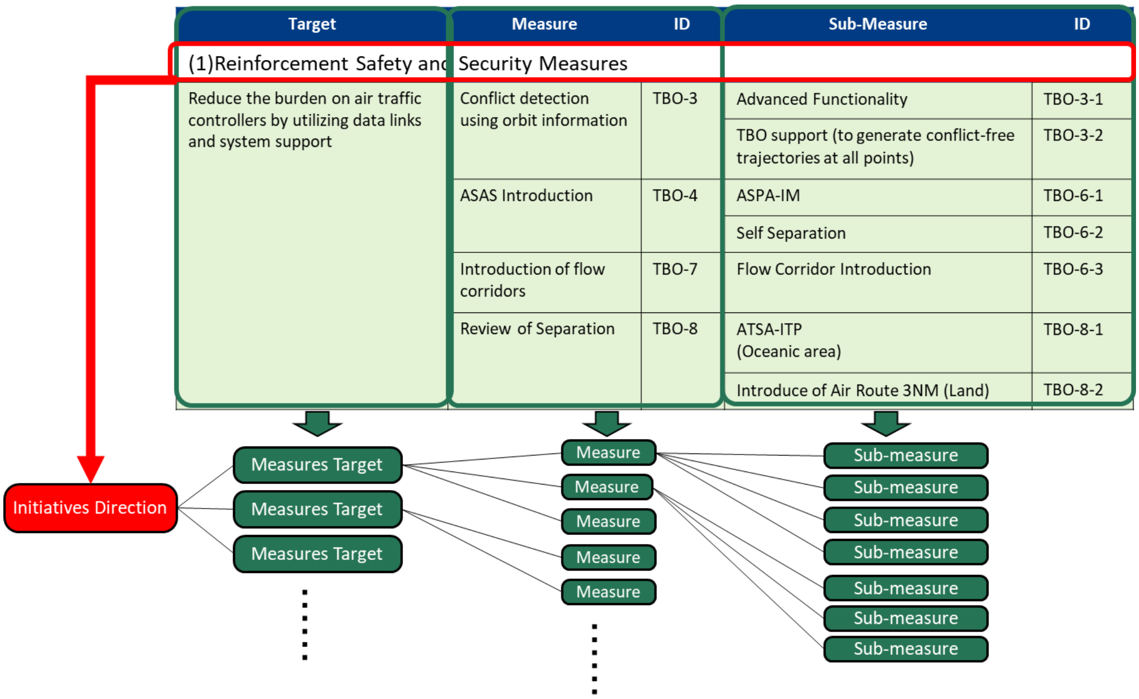
* Planning and coordination meetings and working groups under the Committee for Promoting Renovation of the Air Traffic Systems was also held as necessary.

Appendix

CARATS Roadmap

The specific elements identified in (1) to (6) in the main text under chapter 4 (Future Direction of Initiatives) were broken down into multiple components and positioned as policy objectives.

Furthermore, the roadmap has been created that outlines the policies and sub-policies necessary to achieve each policy objective, along with target years for research and development, implementation, and operational launch.



Target	Measure	ID	Sub-Measure	ID
(1)Reinforcement Safety and Security Measures				
Reduce the burden on air traffic controllers by utilizing data links and system support	Conflict detection using orbit information	TBO-3	Advanced Functionality	TBO-3-1
			TBO support (to generate conflict-free trajectories at all points)	TBO-3-2
	ASAS Introduction	TBO-4	ASPA-IM	TBO-6-1
			Self Separation	TBO-6-2
	Introduction of flow corridors	TBO-7	Flow Corridor Introduction	TBO-6-3
	Review of Separation	TBO-8	ATSA-ITP (Oceanic area)	TBO-8-1
			Introduce of Air Route 3NM (Land)	TBO-8-2

The structure of CARATS Roadmap

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legends
R&D ,etc.
maintenance etc.(prior to decision making)
Maintenence etc.(After decision making)
Items under consideration
◆ Target decision making year
★ target year of start operation

CARATS2040 Roadmap

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
(1) Enhancing Safety and Security																							
Safe and efficient takeoffs, landings, and ground movement, etc.	Detection and warning of dangerous situations	SAF-1	Introduction of Voice Recognition Technology	SAF-1-1	R&D				◆ Introduction of Voice Recognition Technology			★										Safety Enhancement Study Group	
			Introduction of image recognition technology, etc.	SAF-1-2	R&D				◆ Introduction of image recognition technology, etc.			★											
	Enhancing Surveillance Capabilities Using ADS-B	SUR-1	ADS-B (Airport Surface) Implementation	SUR-1-3	ADS-B (Airport Surface) Implementation			★															
	Organizing of takeoffs and landings (AMAN/DMAN/SMAN)	APO-1	AMAN Enhancement	APO-1-1	AMAN Enhancement						★												
			Integrated Operation of AMAN/DMAN/SMAN	APO-1-2	Integrated Operation of AMAN/DMAN/SMAN						★												
	Introduction of the Advanced Surface Movement Guidance and Control System(A-SMGCS)	SAF-2	A-SMGCS Lv.4 (Surveillance functions, Routing function, Guidance Functions)	SAF-2-1	Research R&D	◆ System Development/Maintenance of Aeronautical Lighting									★	Trial operation	Full-scale operation and expanded implementation						
	Caution in case of Runway Incursions	SAF-3	Development of Warning Systems for Approaching Aircraft using Aeronautical Lighting	SAF-3-1	R&D		Evaluation, Verification, and Standardization Activities				◆ Development of a Warning System for Landing Aircraft Using Aeronautical Lighting						★						
			Study of Runway Incursion Detection Systems (SURF-A, etc.)	SAF-3-2	Monitoring overseas trends/Certification/Sequential implementation																		
	Enhancement of External Monitoring	SAF-4	Development and Implementation of Digital Towers	SAF-4-1	R&D					Implementation of Digital Towers					★								
Optimization and Organization of Air Traffic	Enhancement of Communication Applications	COM-1	CPDLC (FANS 1/A+／ATN-B2)	COM-1-1		◆	Enhancement(CPDLC(ATN-B2))						★									CNS Review Working Group Communications Studying Group	
			DCL (ARINC／ATN-B2)	COM-1-2			◆	Enhancement(DCL(ATN-B2))					★										
			D-TAXI (ATN-B2)	COM-1-3				◆	D-TAXI					★									
			D-RVR/HZWX (ATN-B2)	COM-1-4				◆	D-RVR/HZWX					★									
			4DTRAD (ATN-B2)	COM-1-5								◆	FLIPINT/4DTRAD/EPP etc							★			
			Dynamic RNP (ATN-B2)	COM-1-6								◆	Dynamic RNP							★			

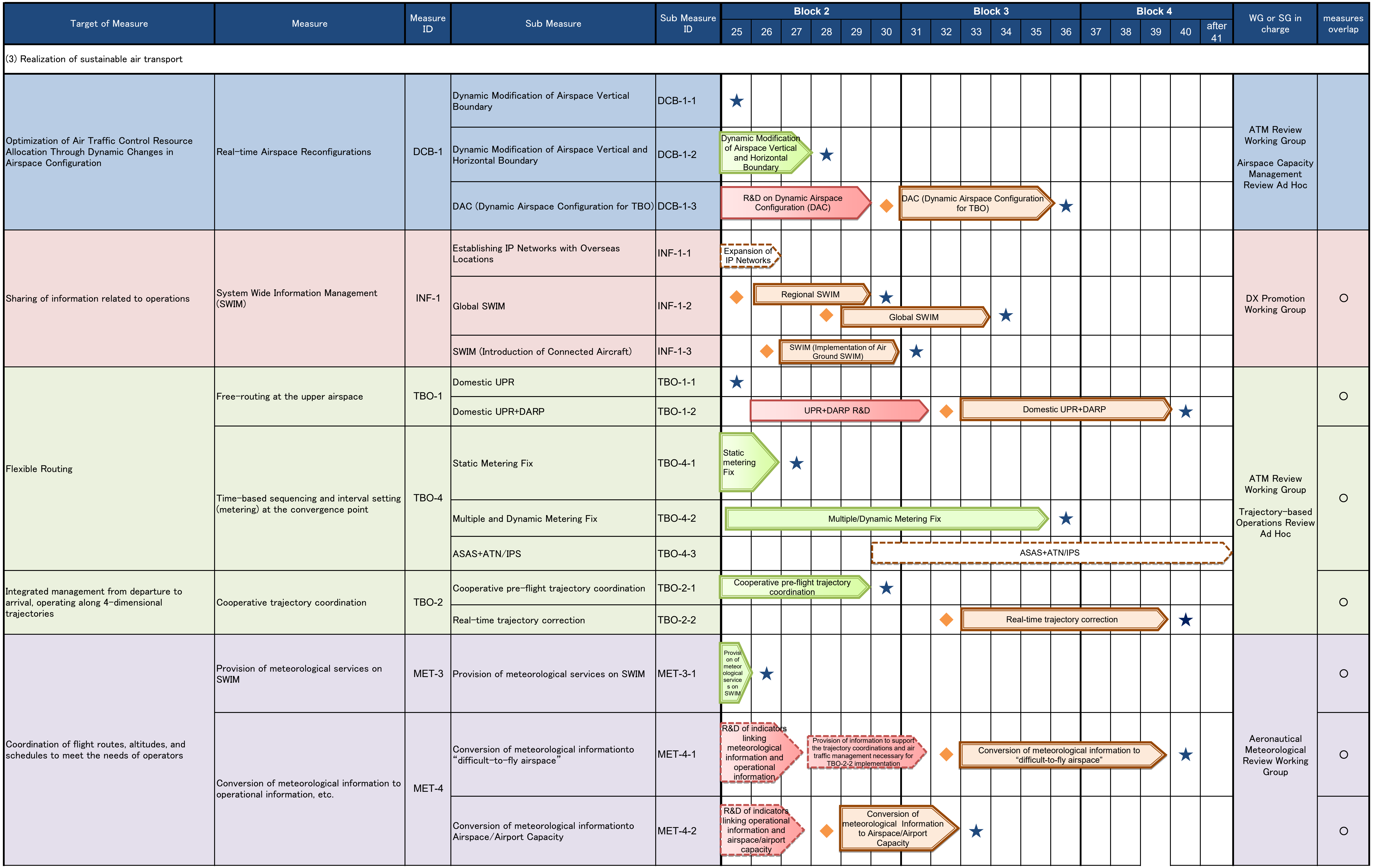
Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
Expansion and Enhancement of Meteorological Observation and Forecast Information	Expansion and Enhancement of Meteorological Observation Information	MET-1	Utilization of Meteorological Observation Data via DAPs	MET-1-1	Utilization of Meteorological Observation Data via DAPs				★													Aviation Meteorology Review Working Group	
			Utilization of EDR	MET-1-2	◆	Utilization of EDR					★												
			Study on Enhancing Meteorological Observation Information Using Multiple Observation Data	MET-1-3	Feasibility Study																		
	Expansion and Enhancement of Meteorological Forecast Information	MET-2	Provision of quantitative volcanic ash information	MET-2-1	Provision of quantitative volcanic ash information	★																	
Reducing the workload of controllers and others through the use of data links and system support	Conflict Detection Using Trajectory Information	TBO-3	Functional Enhancement	TBO-3-1	◆	Functional Enhancement					★											ATM Review Working Group Trajectory-Based Operations Study Ad Hoc	
			Generation of conflict-free trajectories at all way points	TBO-3-2								◆	Generation of conflict-free trajectories at all way points							★			
	Introduction of ASAS	TBO-6	ASPA-IM	TBO-6-1	ASPA-IM R&D/Evaluation					◆	ASPA-IM				★								
			Self separation	TBO-6-2							Self separation R&D/Evaluation					◆	Self separation						
	Introduction of Flow Corridor	TBO-7	Introduction of Flow Corridor	TBO-7-1												◆	Introduction of Flow Corridor						
	Review of the Separation Standards	TBO-8	ATSA-ITP (Oceanic area)	TBO-8-1	★																		
			Introduction of 3NM separation on en-Route (Continental)	TBO-8-2	◆	Introduction of 3NM separation on en-Route (Continental)					★												
･Reducing the workload of controllers and others through the use of data links and system support ･Expanding and enhancing meteorological observation and forecast information	Introduction of Downlink of Aircraft Movement Information (DAPs)	SUR-3	Wind Direction and Speed Calculation Function	SUR-3-1	★																	CNS Review Working Group Surveillance Study Group	
			DAPs Interrogation Control Functionality and Reliability Enhancement	SUR-3-2	★																		
			Expanding DAPs Information Types (including Meteorological Information)	SUR-3-3	R&D on Expanding DAPs Information Types			◆	Expansion of DAPs			★											
	Utilization of Downlink of Aircraft Movement Information(DAPs)	SUR-4	Utilization of Wind Direction and Wind Speed at the ATC Console	SUR-4-1	★																		
			Improvement of Tracking Accuracy	SUR-4-2	Improved Tracking Accuracy R&D			◆	Improvement of Tracking Accuracy					★									

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
(2)Realization of trajectory-based operations (TBO) for optimal aircraft operations																							
Time management operations for departure times, times of passage through specific points, and subsequent arrival times of all aircraft	Integration of ATFM with Related Measures (A-CDM, etc.) and Enhancement of ATFM	DCB-3	Integration of ATFM with Related Measures (A-CDM, etc.) and Advancement of ATFM	DCB-3-1							Integration of ATFM with Related Measures (A-CDM, etc.) and Advancement of ATFM											ATM Review Working Group Airspace Capacity Management study Ad Hoc Group	
Time management operations for departure times, times of passage through specific points, and subsequent arrival times of all aircraft	Organizing of takeoffs and landings (AMAN/DMAN/SMAN)	APO-1	Enhancement of AMAN	APO-1-1	Enhancement of AMAN						★											ATM Review Working Group Airport Operations Study Ad Hoc	○
			Integrated Operation of AMAN/DMAN/SMAN	APO-1-2	Integrated Operation of AMAN/DMAN/SMAN						★												
	Airport-CDM(A-CDM)	APO-2	Deployment to other airports	APO-2-1	◆	Deployment to other airports				★													
			Enhancement	APO-2-2	◆	Enhancement				★													
Minimizing aircraft separation using data link and system support	Reduction of separation due to wake turbulence	APO-3	TBS for Arriving Aircraft	APO-3-1	R&D of Technology to Reduce the Effects of Wake			◆	TBS for Arriving Aircraft				★										
			Review Pairwise Separation Standards	APO-3-2						◆	Review Pairwise Separation Standards				★								
			TBS for Departuring Aircraft	APO-3-3						◆	TBS for Departuring Aircraft				★								

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
Flexible Routing	Free-routing at the upper airspace	TBO-1	Domestic UPR	TBO-1-1	★																	ATM Review Working Group Trajectory-based Operations Review Ad Hoc	
			Domestic UPR+DARP	TBO-1-2		UPR+DARP R&D						◆	Domestic UPR+DARP							★			
	Time-based sequencing and interval setting (metering) at the convergence point	TBO-4	Static Metering Fix	TBO-4-1	Static Metering Fix		★																
			Multiple and Dymnamic Metering Fix	TBO-4-2	Multiple and Dymnamic Metering Fix											★							
			ASAS+ATN/IPS	TBO-4-3						ASAS+ATN/IPS													
Integrated management from departure to arrival, operating along a 4-dimensional trajectory	Cooperative trajectory coordination	TBO-2	Pre-Flight trajectory Coordination	TBO-2-1	Pre-Flight Trajectory Coordination					★													
			Real-time trajectory correction	TBO-2-2								◆	Real-time trajectory correction							★			
Reducing the workload of controllers and others through the use of data links and system support	Conflict Detection Using Trajectory Information	TBO-3	Functional Enhancement	TBO-3-1	◆	Functional Enhancement					★												○
			Generation of conflict-free trajectories at all way points	TBO-3-2								◆	Generation of conflict-free trajectories at all way points							★			
	Introduction of ASAS	TBO-6	ASPA-IM	TBO-6-1	R&D and Evaluation of ASPA-IM					◆	ASPA-IM				★								○
			Self separation	TBO-6-2							R&D and Evaluation of Self-Separation					◆	Self separation						○
	Introduction of Flow Corridor	TBO-7	Introduction of Flow Corridor	TBO-7-1												◆	Introduction of Flow Corridor						
	Review of the Separation Standards	TBO-8	ATSA-ITP（Oceanic area)	TBO-8-1	★																		○
			Introduction of 3NM separation on en-Route (Continental)	TBO-8-2	◆	Introduction of 3NM separation on en-Route (Continental)					★												
Optimization of Vertical Profile	Continuous Climb/Descent Operations	TBO-5	CCO	TBO-5-1	CCO		★																
			Enhancing CDO via Data Link (CTO Assignment, ATN-B2, etc.)	TBO-5-2		◆	Enhancing CDO via Data Link (CTO Assignment, ATN-B2, etc.)				★												

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
Sharing of information related to operations	System Wide Information Management (SWIM)	INF-1	Establishing IP Networks with Overseas Locations	INF-1-1	IP Network Expansion	→																DX Promotion Working Group	
			Global SWIM	INF-1-2	◆	Regional SWIM	→	→ ◆	→ Global SWIM	★ →	→	→	→	★									
			SWIM (Introduction of Connected Aircraft)	INF-1-3		◆	SWIM (Implementation of Air Ground SWIM)	→	→	→	★												
	Digitization of information	INF-2	Introduction of FF-ICE Messages	INF-2-1	FF-ICE Messages	→ ◆	★ Message Extension	→	→	→	★												
			Enhancement of Aeronautical Information	INF-2-2		◆	Enhancement of Aeronautical Information	→	→	→	→	★											
			Providing Information to the New AU	INF-2-3	Providing Information to the New AU	→	→	→	→	→	→	→											
			Enhancement of Onboard Information	INF-2-4	Enhancement of Onboard Information	→	→	→	→	→	→	→											
			Enhancement of information on the ground	INF-2-5	Enhancement of information on the ground	→	→	→	→	→	→	→											
Enhancement and Advancement of Meteorological Observation and Forecast Information	Enhancement and Advancement of Meteorological Observation Information	MET-1	Utilization of Meteorological Observation Data via DAPs	MET-1-1	Utilization of Meteorological Observation Data via DAPs	→	→	→	★													Aeronautical Meteorological Review Working Group	○
	Enhancement and Advancement of Weather Forecast Information	MET-2	Provision of quantitative volcanic ash information	MET-2-1	Provision of quantitative volcanic ash information	★																	○
Coordination of flight routes, altitudes, and schedules to meet the needs of operators	Provision of meteorological services on SWIM platform	MET-3	Provision of meteorological services on SWIM platform	MET-3-1	Provision of meteorological services on SWIM patfor	★																	
	Conversion of meteorological information to operational information, etc.	MET-4	Conversion of meteorological information to "difficult-to-fly airspace"	MET-4-1	R&D of indicators linking meteorological information and operational	→	→	Provision of information to support the trajectory coordination and air traffic management necessary for TBO-2-2 implementation	→	→	→	◆	Conversion from Meteorological information to "difficult-to-fly airspace"	→	→	→	→	→	→	★			
			Conversion of Meteorological Information to Airspace/Airport Capacity	MET-4-2	R&D of indicators linking operational information and airspace/airport capacity	→	→	◆	Conversion from Meteorological Information to Airspace/Airport Capacity	→	→	→	★										
			Conversion of meteorological information to optimal control intervals considering wake turbulence	MET-4-3	R&D of indicators linking meteorological information and minimum separation intervals	→	→	◆	TBS for Arriving Aircraft	→	→	→	★										

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
Shortening the flight distance	RNP/GNSS-based operations (Operational procedure)	NAV-1	Improvement of RAIM Prediction Performance (for LP/LPV)	NAV-1-1	Performance Improvement for LP/LPV		★															CNS Review Working Group Navigation Study Group	
			Expansion and Enhancement of LP/LPV implementation	NAV-1-2	LP/LPV		★																
			Approach procedure connecting from RF turn (RNP to LPV)	NAV-1-3	Approach procedure connecting from RF turn (RNP to LPV)					★													
			Approach procedure connecting from RF turn (RNP to GLS)	NAV-1-4	Approach procedure connecting from RF turn (RNP to GLS)			★															
			GLS Approach（CATⅡ/Ⅲ）	NAV-1-5	GLS Approach(CAT-Ⅱ,Ⅲ)																		
			Enhancement of GBAS	NAV-1-6	R&D and Evaluation of Enhanced GBAS																		
			Study on High-Precision Departure Procedure Using PBN	NAV-1-7	High-Precision Departure Procedure Using PBN ICAO Regulation Review Status Confirmation																		
			RNP2 (Reduced Lateral Separation)	NAV-1-8	RNP2 (Reduced Lateral Separation)				★														
			Advanced RNP（TOAC） Time Of Arrival Control Function	NAV-1-9	Advanced RNP(TOAC) Time Of Arrival Control Function																		
Enhancement and Advancement of Weather Observation and Forecast Information Reducing the workload of controllers and other personnel through the use of data links and system support	Introduction of Downlink Aircraft Parameters (DAPs)	SUR-3	Wind Direction and Speed Calculation Function	SUR-3-1	★																	CNS Review Working Group Surveillance Study Group	○
			DAPs Interrogation Control Functionality and Reliability Enhancement	SUR-3-2	★																		
			Expanding DAPs Information Types (including Meteorological Information)	SUR-3-3	R&D on Expanding DAPs Information Types			◆	Expansion of DAPs Information Types			★											
	Utilization of Downlink Aircraft Parameters (DAPs)	SUR-4	Utilization of Wind Direction and Wind Speed at the ATC Console	SUR-4-1	★																		○
			Improvement of Tracking Accuracy	SUR-4-2	R&D for Improvement of Tracking Accuracy			◆	Improvement of Tracking Accuracy					★									



Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
(3) Realization of sustainable air transport																							
Optimization of Air Traffic Control Resource Allocation Through Dynamic Changes in Airspace Configuration	Real-time Airspace Reconfigurations	DCB-1	Dynamic Modification of Airspace Vertical Boundary	DCB-1-1	★																	ATM Review Working Group Airspace Capacity Management Review Ad Hoc	
			Dynamic Modification of Airspace Vertical and Horizontal Boundary	DCB-1-2	Dynamic Modification of Airspace Vertical and Horizontal Boundary			★															
			DAC (Dynamic Airspace Configuration for TBO)	DCB-1-3	R&D on Dynamic Airspace Configuration (DAC)					◆	DAC (Dynamic Airspace Configuration for TBO)					★							
Sharing of information related to operations	System Wide Information Management (SWIM)	INF-1	Establishing IP Networks with Overseas Locations	INF-1-1	Expansion of IP Networks																	DX Promotion Working Group	○
			Global SWIM	INF-1-2	◆	Regional SWIM				★													
								◆	Global SWIM					★									
			SWIM (Introduction of Connected Aircraft)	INF-1-3		◆	SWIM (Implementation of Air Ground SWIM)				★												
Flexible Routing	Free-routing at the upper airspace	TBO-1	Domestic UPR	TBO-1-1	★																	ATM Review Working Group Trajectory-based Operations Review Ad Hoc	○
			Domestic UPR+DARP	TBO-1-2		UPR+DARP R&D						◆	Domestic UPR+DARP							★			
	Time-based sequencing and interval setting (metering) at the convergence point	TBO-4	Static Metering Fix	TBO-4-1	Static metering Fix		★																○
			Multiple and Dynamic Metering Fix	TBO-4-2	Multiple/Dynamic Metering Fix											★							
			ASAS+ATN/IPS	TBO-4-3						ASAS+ATN/IPS													
Integrated management from departure to arrival, operating along 4-dimensional trajectories	Cooperative trajectory coordination	TBO-2	Cooperative pre-flight trajectory coordination	TBO-2-1	Cooperative pre-flight trajectory coordination					★													○
			Real-time trajectory correction	TBO-2-2								◆	Real-time trajectory correction							★			
Coordination of flight routes, altitudes, and schedules to meet the needs of operators	Provision of meteorological services on SWIM	MET-3	Provision of meteorological services on SWIM	MET-3-1	Provision of meteorological services on SWIM	★																Aeronautical Meteorological Review Working Group	○
	Conversion of meteorological information to operational information, etc.	MET-4	Conversion of meteorological informationto "difficult-to-fly airspace"	MET-4-1	R&D of indicators linking meteorological information and operational information			Provision of information to support the trajectory coordinations and air traffic management necessary for TBO-2-2 implementation				◆	Conversion of meteorological information to "difficult-to-fly airspace"							★			○
			Conversion of meteorological informationto Airspace/Airport Capacity	MET-4-2	R&D of indicators linking operational information and airspace/airport capacity			◆	Conversion of meteorological Information to Airspace/Airport Capacity				★										○

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	after 41		
Reducing the workload of controllers and other personnel through the use of data links and system support	Review of the Separation Standards	TBO-8	ATSA-ITP (Oceanic area)	TBO-8-1	★																	ATM Review Working Group Trajectory-based Operations Review	○
			Introduction of 3NM separation on En-route (Continental)	TBO-8-2	◆	Introduction of 3NM separation on en-Route (Continental)					★												
・Improved landing opportunities ・Shortening of flight distance	RNP/GNSS-based operations (Operational procedure)	NAV-1	Improvement of RAIM Prediction Performance (for LP/LPV)	NAV-1-1	Performance Improvement for LP/LPV		★															CNS Review Working Group Navigation Study Group	○
			Expansion and Enhancement of LP/LPV implementation	NAV-1-2	LP/LPV		★																
			Approach procedure connecting from RF turn (RNP to LPV)	NAV-1-3	Approach procedure connecting from RF turn (RNP to LPV)					★													
			Approach procedure connecting from RF turn (RNP to GLS)	NAV-1-4	Approach procedure connecting from RF turn (RNP to GLS)			★															
			GLS Approach（CATⅡ/Ⅲ）	NAV-1-5	GLS Approach(CAT-Ⅱ,Ⅲ)																		
			Enhancement of GBAS	NAV-1-6	Enhanced GBAS R&D and Evaluation																		
			Study on High-Precision Departure Procedure Using PBN	NAV-1-7	High-Precision Departure Procedure Using PBN ICAO Regulation Review Status Confirmation																		
			RNP2 (Reduced Lateral Separation)	NAV-1-8	RNP2 (Reduced Lateral Separation)				★														
			Advanced RNP（TOAC） Time Of Arrival Control Function	NAV-1-9	Advanced RNP(TOAC) Time Of Arrival Control Function																		
Optimization of Vertical Profile	Continuous Climb/Descent Operations	TBO-5	CCO	TBO-5-1	CCO		★															ATM Review Working Group Trajectory-based Operations Review Ad Hoc	○
			Enhancing CDO via Data Link (CTO Assignment, ATN-B2, etc.)	TBO-5-2		◆	Enhancing CDO via Data Link (CTO Assignment, ATN-B2, etc.)				★												
Time management operations for strategically managing aircraft departure times, times of passage over specific points, and arrival times	Organizing of takeoffs and landings (AMAN/DMAN/SMAN)	APO-1	AMAN Enhancement	APO-1-1	AMAN Enhancement						★											ATM Review Working Group Airport Operations Review Ad Hoc	○
			Integrated Operation of AMAN/DMAN/SMAN	APO-1-2	Integrated Operation of AMAN/DMAN/SMAN						★												
	Airport-CDM(A-CDM)	APO-2	Enhancement	APO-2-2	◆	Enhancement				★													○

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
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(4) Effective use of airspace that accommodates the diversification of air mobility																							
Airspace Segregation by Air Mobility Category	Study of Operational Rules and Infrastructure for Airspace Segregation	NAM-1	Study of Operational Rules and Infrastructure for Airspace Segregation	NAM-1-1	Study of Operational Rules and Infrastructure for Airspace Segregation Research and Development, etc..																	New Aviation Mobility Working Group	
Ensuring Safety Intervals Between Airl Mobilities	Review of Safety Intervals Between air Mobilities	NAM-2	Review of Safety Intervals Between Air Mobilities	NAM-2-1							Review of Safety Intervals Between Aerial Mobilities												
Sharing and coordination of detailed information regarding airspace and operations among air mobilities	Sharing and coordination of detailed information regarding the airspace and operations used by each air mobilities	NAM-3	Sharing and coordination of detailed information regarding the airspace and operations used by each air mobilities	NAM-3-1		Sharing and adjustment of detailed information regarding the airspace and operations used by each aerial mobilities																	
･Improved landing opportunities ･Shortening of flight distance	RNP/GNSS-based operations (Operational procedure)	NAV-1	Improvement of RAIM Prediction Performance (for LP/LPV)	NAV-1-1	Performance Improvement for LP/LPV		★															CNS Review Working Group Navigation Study Group	○
			Expansion and Enhancement of LP/LPV implementation	NAV-1-2	LP/LPV		★																
			Approach procedure connecting from RF turn (RNP to LPV)	NAV-1-3	Approach procedure connecting from RF turn (RNP to LPV)					★													
			Approach procedure connecting from RF turn (RNP to GLS)	NAV-1-4	Approach procedure connecting from RF turn (RNP to GLS)			★															
			GLS Approach（CAT Ⅱ/Ⅲ）	NAV-1-5	GLS Approach（CAT-Ⅱ,Ⅲ）																		
			Enhancement of GBAS	NAV-1-6	Enhanced GBAS R&D and Evaluation																		
			Study on High-Precision Departure Procedure Using PBN	NAV-1-7	High-Precision Departure Procedure Using PBN ICAO Regulation Review Status Confirmation																		
			RNP2 (Reduced Lateral Separation)	NAV-1-8	RNP2 (Reduced Lateral Separation)				★														
			Advanced RNP（TOAC） Time Of Arrival Control Function	NAV-1-9	Advanced RNP(TOAC) Time Of Arrival Control Function																		
Improved landing opportunities	Introduction of an Operation Procedure Using Visual Support Devices	NAV-5	EVS (EFVS) Operation	NAV-5-1	EVS (EFVS) Issue Review																		

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
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Flexible Routing	Free -routing at the upper airspace	TBO-1	Domestic UPR	TBO-1-1	★																	ATM Review Working Group Trajectory-based Operations Review Ad Hoc	○
			Domestic UPR+DARP	TBO-1-2		UPR+DARP R&D						◆	Phase 3(UPR+DARP)							★			
	Time-based sequencing and interval setting (metering) at the convergence point	TBO-4	Static Metering Fix	TBO-4-1	Static metering fix		★																○
			Multiple and Dynamic Metering Fix	TBO-4-2	Multiple and Variable metering fix											★							
			ASAS+ATN/IPS	TBO-4-3						ASAS+ATN/IPS													
Flexible Routing	Operations of Small Aircrafts	NAV-4	High-Angle Approach for Helicopters	NAV-4-1							High-Angle Approach for Helicopters											CNS Review Working Group Navigation Study Group	○
			Low-Altitude RNP	NAV-4-2	RNP0.3/2 Review and Equipment Status Confirmation																		
Optimization of Air Traffic Control Resource Allocation Through Dynamic Changes in Airspace Configuration	Real-time Airspace Reconfigurations	DCB-1	Dynamic Modification of Airspace Vertical Boundary	DCB-1-1	★																	ATM Review Working Group Airspace Capacity Management Review Ad Hoc	○
			Dynamic Modification of Airspace Vertical and Horizontal Boundary	DCB-1-2	Dynamic Modification of Airspace Vertical and Horizontal Boundary			★															
			DAC (Dynamic Airspace Configuration for TBO)	DCB-1-3	Research and Development on Dynamic Airspace Configuration (DAC)					◆	DAC (Dynamic Airspace Configuration for TBO)					★							
・Optimization of Air Traffic Control Resource Allocation Through Dynamic Changes in Airspace Configuration ・Reducing the workload of controllers and other personnel through the use of data links and system support	Flexible airspace sector management through accurate sector capacity and demand assessment based on trajectory information	DCB-2	Complexity Management	DCB-2-1	R&D on Complexity Management					◆	Complexity Management					★							
Reducing the workload of controllers and other personnel through the use of data links and system support	Conflict Detection Using trajectory Information	TBO-3	Functional Enhancement	TBO-3-1	◆	Functional Enhancement					★											ATM Review Working Group Trajectory-based Operations Review Ad Hoc	○
			Generation of conflict-free trajectories at all way points	TBO-3-2								◆	Generation of conflict-free trajectories at all way points							★			
	Introduction of ASAS	TBO-6	ASPA-IM	TBO-6-1	R&D and Evaluation of ASPA-IM					◆	ASPA-IM				★								○
			Self separation	TBO-6-2							R&D and Evaluation of Self-Separation					◆	Self separation						
	Introduction of Flow Corridor	TBO-7	Introduction of Flow Corridor	TBO-7-1												◆	Introduction of Flow Corridor						○
	Review of the Separation Standards	TBO-8	ATSA-ITP (Oceanic area)	TBO-8-1	★																		○
			Introduction of 3NM separation on en-Route (Continental)	TBO-8-2	◆	Introduction of 3NM separation on en-Route (Continental)					★												

Target of Measure	Measure	Measure ID	Sub Measure	Sub Measure ID	Block 2						Block 3						Block 4					WG or SG in charge	measures overlap
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･Reducing the workload of controllers and other personnel through the use of data links and system support ･Enhancement and Advancement of Meteorological Observation and Forecast Information	Introduction of Downlink Aircraft Parameters (DAPs)	SUR-3	Wind Direction and Speed Calculation Function	SUR-3-1	★																	CNS Review Working Group Surveillance Study Group	○
			DAPs Interrogation Control Functionality and Reliability Enhancement	SUR-3-2	★																		
			Expanding DAPs Information Types (including Meteorological Information)	SUR-3-3	R&D for Expansion of DAPs Information Types			◆	Expansion of DAPs Information Types			★											
	Utilization of Downlink Aircraft Parameters (DAPs)	SUR-4	Utilization of Wind Direction and Wind Speed at the ATC Console	SUR-4-1	★																		○
			Improvement of Tracking Accuracy	SUR-4-2	R&D for Improving Tracking Accuracy			◆	Improvement of Tracking Accuracy					★									
Enhancement and Advancement of Meteorological Observation and Forecast Information	Enhancement and Advancement of Meteorological Observation Information	MET-1	Utilization of Meteorological Observation Data via DAPs	MET-1-1	Utilization of Meteorological Observation Data via DAPs				★													Aeronautical Meteorological Review Working Group	○

<table>
<tr><th rowspan="2">Target of Measure</th><th rowspan="2">Measure</th><th rowspan="2">Measure ID</th><th rowspan="2">Sub Measure</th><th rowspan="2">Sub Measure ID</th><th colspan="6">Block 2</th><th colspan="6">Block 3</th><th colspan="5">Block 4</th><th rowspan="2">WG or SG in charge</th><th rowspan="2">measures overlap</th></tr>
<tr><th>25</th><th>26</th><th>27</th><th>28</th><th>29</th><th>30</th><th>31</th><th>32</th><th>33</th><th>34</th><th>35</th><th>36</th><th>37</th><th>38</th><th>39</th><th>40</th><th>after 41</th></tr>
<tr><td colspan="24">(5) Strengthening Resilience</td></tr>
<tr><td rowspan="4">•Strengthening Redundancy in Satellite Navigation via DFMC
•Introduction of Alternative Navigation Facilities for GNSS Loss</td><td rowspan="4">RNP/GNSS-based operations
(GNSS Resiliency)</td><td rowspan="4">NAV-2</td><td rowspan="2">Strengthen robustness and interference resistance
(DFMC-compatible SBAS)</td><td rowspan="2">NAV-2-1</td><td></td><td>◆</td><td colspan="10">Strengthen robustness and interference resistance
(DFMC-compatible SBAS)</td><td>★</td><td></td><td></td><td></td><td></td><td rowspan="8">CNS review Working Group
Navigation Study Group</td><td rowspan="4"></td></tr>
<tr><td colspan="12">R&D of DFMC SBAS, ABAS, and A-RAIM</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Strengthen robustness and interference resistance
(DFMC-compliant GBAS)</td><td>NAV-2-2</td><td colspan="5">DFMC GBAS R&D</td><td>◆</td><td colspan="6">Strengthen robustness and interference resistance (DFMC-compliant GBAS)</td><td>★</td><td></td><td></td><td></td><td></td></tr>
<tr><td>GNSS RFI Monitoring</td><td>NAV-2-3</td><td colspan="8">Considerations</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Introduction of Alternative Navigation Facilities in case of GNSS Loss</td><td rowspan="4">RNP/GNSS-based operations
(GNSS Backup)</td><td rowspan="4">NAV-3</td><td>Initial APNT Implementation</td><td>NAV-3-1</td><td>◆</td><td colspan="7">Initial APNT Implementation (DME)</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="4"></td></tr>
<tr><td rowspan="2">APNT Implementation</td><td rowspan="2">NAV-3-2</td><td colspan="8">R&D Related to APNT Implementation</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="14">APNT Implementation (LDACS, etc.)</td></tr>
<tr><td>Maintenance/Optimization of MON</td><td>NAV-3-3</td><td colspan="6">Considerations</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">•Complementarity of surveillance systems
•Enhancement of Airport Surveillance Systems</td><td rowspan="3">Enhancing Surveillance Capabilities Using ADS-B</td><td rowspan="3">SUR-1</td><td>ADS-B-RAD</td><td>SUR-1-1</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="5">CNS Review Working Group
Surveillance Study Group</td><td></td></tr>
<tr><td>ADS-B-NRA</td><td>SUR-1-2</td><td colspan="4">ADS-B-NRA</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ADS-B (Airport Surface)</td><td>SUR-1-3</td><td colspan="3">ADS-B (Airport Surface)</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>○</td></tr>
<tr><td rowspan="2">Complementarity of surveillance systems</td><td rowspan="2">Transition to Performance-Based Surveillance</td><td rowspan="2">SUR-5</td><td>Optimization of Surveillance Systems (En-Route)</td><td>SUR-5-1</td><td colspan="4">R&D for Optimization of Surveillance System (en-route)</td><td>◆</td><td colspan="6">Optimization of en-route Surveillance System</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Optimization of Surveillance Systems (Terminals and Airports)</td><td>SUR-5-2</td><td colspan="5">R&D for Optimization of Surveillance System (Terminal/Airfield)</td><td>◆</td><td colspan="6">Optimization of Terminal/Airports Surveillance System</td><td>★</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Enhancing the continuity of communication services</td><td>Enhancement of Communication System</td><td>COM-2</td><td>ATN/IPS</td><td>COM-2-1</td><td>◆</td><td colspan="7">ATN/IPS</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="4">CNS Review Woring Group
Communications Study Group</td><td></td></tr>
<tr><td rowspan="3">The enhancement of communication media</td><td rowspan="3">COM-3</td><td>AeroMACS</td><td>COM-3-1</td><td>R&D</td><td>◆</td><td colspan="6">AeroMACS</td><td>★</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>LDACS</td><td>COM-3-2</td><td colspan="6">R&D</td><td>◆</td><td colspan="7">LDACS</td><td>★</td><td></td><td></td><td></td></tr>
<tr><td>Hyper-Connected ATM</td><td>COM-3-3</td><td colspan="11">Hyper-Connected ATM</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enhancing Redundancy in Power Equipment for Air Navigation Facilities</td><td>Enhanced Power Supply Redundancy</td><td>EQU-1</td><td>Dual power supply systems, etc.</td><td>EQU-1-1</td><td colspan="17">Enhancing Redundancy in Power Equipment for Aviation Security Facilities</td><td>CNS Review Working Group
Power Supply Study Group</td><td></td></tr>
</table>

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(6) Strengthening international cooperation and promoting overseas expansion																							
International Contribution	Overseas Expansion of Japanese Products	INT-1	Overseas Expansion of Japanese Products	INT-1-1	Developing strategies for the overseas expansion of Japanese products																	International Relations SG	
	International Contribution	INT-2	International Contribution	INT-2-1	Coordinate with relevant measures in response to partner country requests and international standardization strategies, and																		

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Committee for Promoting Renovation of the Air Traffic Systems

https://www.mlit.go.jp/koku/carats/