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Ministry of Land, Infrastructure and Transport

# Enhancing ATM Operational Efficiency for Carbon Emission Reduction : with a focus on the NANP(NARAE)

National ATM Reformation And Enhancement

# CONTENTS

# 1. ICAO Global Air Navigation Plan (GANP)

**Vision**

**To achieve a global air traffic management system interoperable with any users in all flight phases, an agreed safety level, optimal economic operations, environmental sustainability, and the requirements for the national security should be met**

## • GANP - Global Strategy

### Sustainable Development

- Sustainable air transport growth depends on a high-performing and seamless global navigation system.
- The global air navigation system ensures safe aviation through the collaborative integration of humans, information, technology, facilities and services.
- Greater connection of passengers and goods, ensuring the sustainability of the growing aviation industries

**Global Air Navigation System**

**Technical scope**

- Aerodrome operations
- Air traffic management
- Meteorology
- Aeronautical information
- Search and rescue services supported by air, ground and space-based CNS capabilities

**Operational scope**

- En-route operations to integrate airport operations and flight turnaround.

**Community scope**

- All stakeholders involved in the provision of, or requiring the use of, air navigation resources.

### PBO Approach

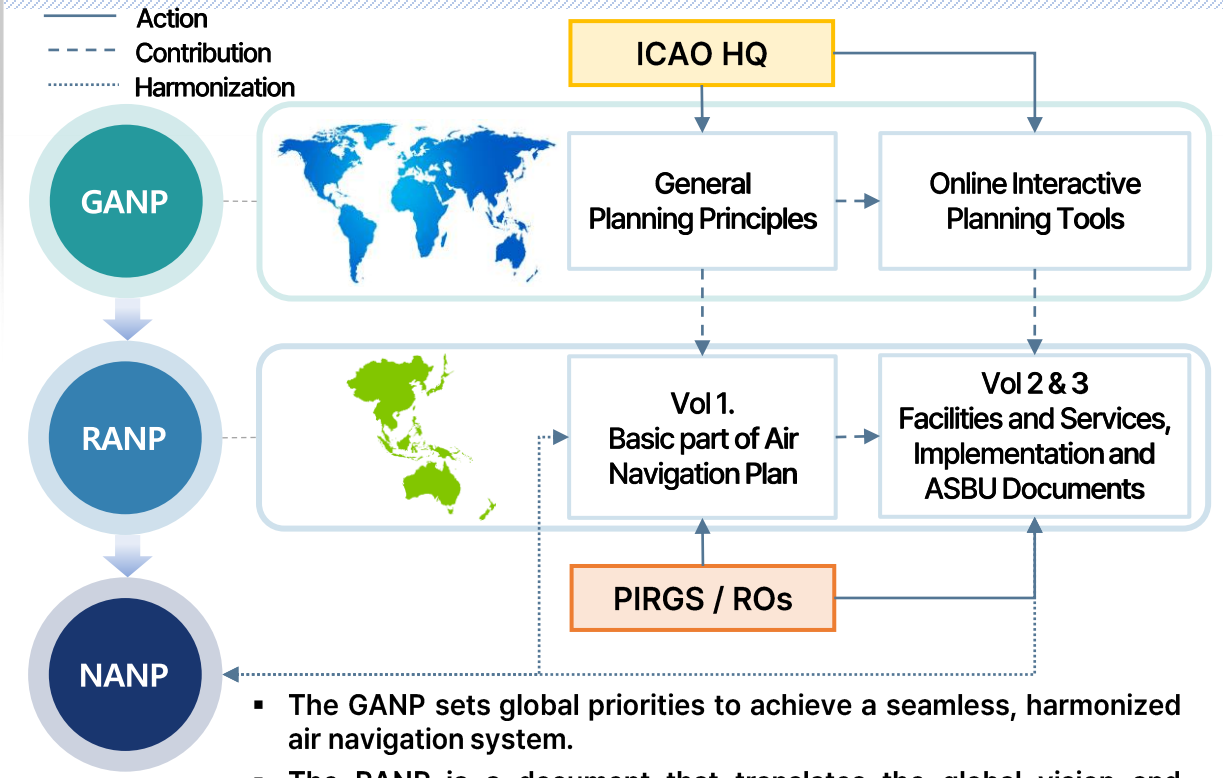
- In addition to the fundamental aviation performance principles of safety, security and environmental and economic sustainability , 11 Key Performance Areas (KPAs) are provided as performance requirements.
- Global air navigation system built on agreed Performance based standards* (ASBU frameworks) in accordance with specific operations and requirements should be implemented as needed.

*In the past, the modernization of air navigation systems was guided by technological innovations implemented at individual state levels which created a gap between aviation ecosystems leading to global disparities. To reduce the disparities, a PBO approach is required

| Society Outcome | Operational Performance | Performance Enablers |
|---|---|---|
| • Safety<br>• Security<br>• Environment | • Cost-effectiveness<br>• Capacity<br>• Efficiency<br>• Predictability<br>• Flexibility | • Global Interoperability<br>• Access and equity<br>• Participation by the ATM community |
| High External Visibility | Medium External Visibility | Low External Visibility |

# 2. ICAO APAC Seamless ANS Plan (RANP)

**Notwithstanding Asia Pacific RANP sharing a common strategy of GANP pursuing modernization of ANS, RANP Vol.1 additionally requires collaborative actions on Air Transportation in Asia Pacific Region.**




- The GANP sets global priorities to achieve a seamless, harmonized air navigation system.
- The RANP is a document that translates the global vision and strategy of the ICAO GANP into plans tailored to the regional context.
- **The NANP is under the responsibility of the State, focuses on national planning.**

## Environment Considerations

- The State Action Plans on CO2 Emissions Reduction coordinated together.
- Decision Making utilizing the results of environmental analysis.
- ICAO's Fuel Savings Estimation Tool(IFSET) available to help quantify environmental benefits.
- Environmental considerations must not compromise the acceptable level of safety and should be balanced with operational and economic factors.

## Civil/Military Co-op Mechanisms

- Civil/military cooperation to enhance the Flexible Use of Airspace leading to more direct routing with savings in fuel and associated emissions.
- Close coordination between civil ATS units and relevant military operational control units.

# 3. National ATM Reformation and Enhancement (NARAE)

## 01 Development of GANP and RANP

- ICAO recommends each state to establish its customized National Air Navigation Plan considering their Regional Air Navigation Plan.

## 02 Increased Air Traffic Demand

- Several solutions such as Flow Management are in place to handle the air traffic volume.
- Civil-military cooperation is ongoing to set an environment of flexible airspace operations.

## 03 Advent of UAM

- The feasibility of Urban Air Mobility (UAM) with its early commercialization and market growth has been rising via changing forms of transport and technological development.

## 04 Importance of environmental impacts

- For the protection of international aviation environment, countries around the world participating in efforts such as optimizing flight procedures to reduce fuel burn and implementing the Carbon Offsetting Reduction Scheme for International Aviation(CORSIA).

**The National Air Navigation Plan(NARAE, National ATM Reformation And Enhancement) is needed to respond to changing conditions and manage air traffic safely and efficiently.**

# 3. National ATM Reformation and Enhancement (NARAE)

"Considerations for ATM Efficiency to Reduce Carbon Emissions"

- Flexible Paths
- User-Preferred Routes
- Dynamic Airborne Reroute Procedure
- Continuous Climb Operations and Continuous Descent Operations
- Arrival Management and Departure Management Integration
- ⋮

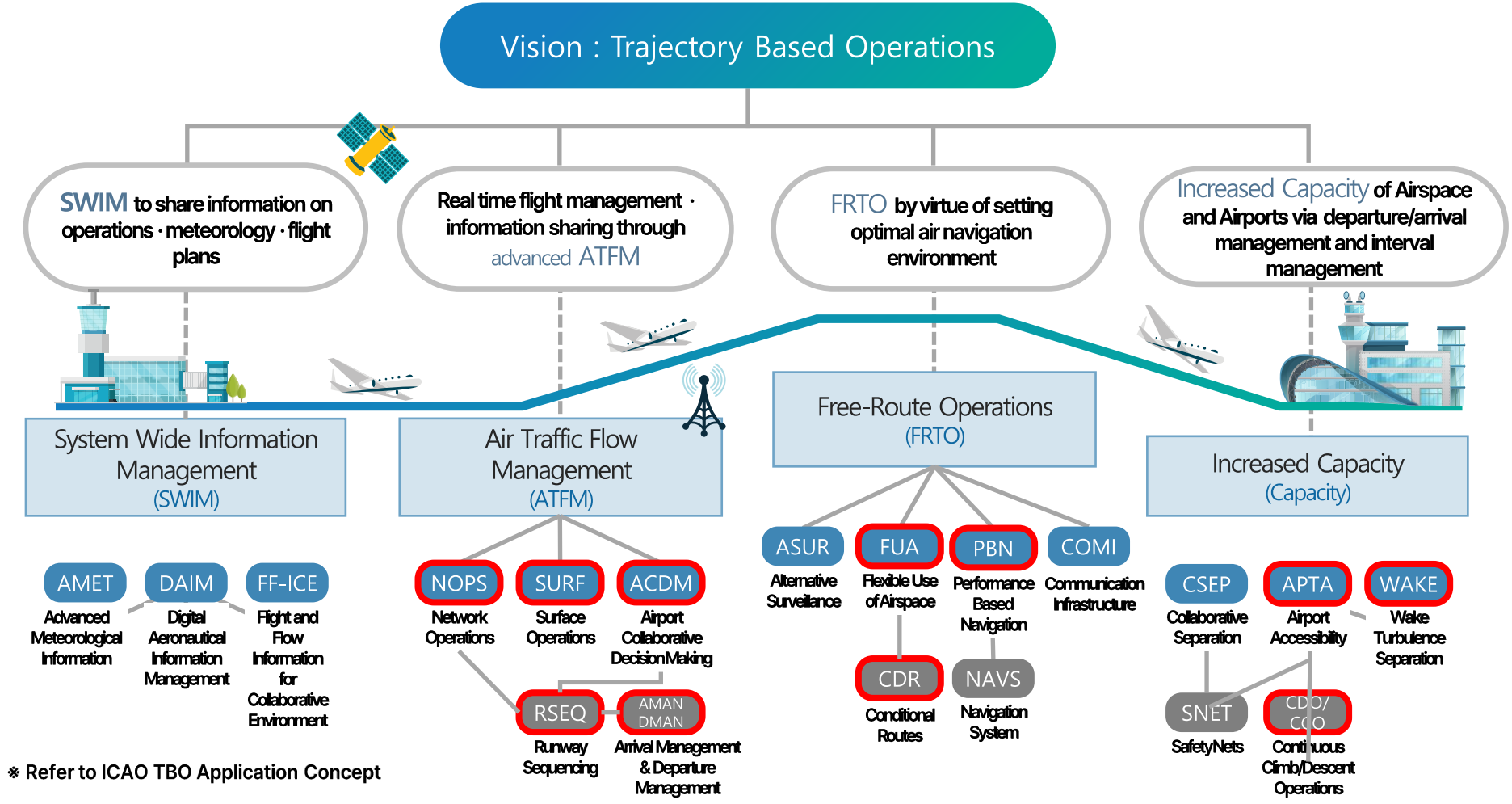
## Trajectory Based Operation (TBO)

- TBO is fundamental to realizing the ICAO Global ATM Operational Concept.
- Sharing of trajectory information and providing access to the best data.
- Managing trajectory information using Collaborative Decision Making(CDM)
- Using a shared trajectory as a unified flight plan with common goals.

**Expected Benefits of Implementing TBO in ATM Operations for Carbon Reduction**

Airspace and Airport Throughput ↑ | Operational Predictability Flexibility ↑ | Fuel burn and $CO_2$ Emissions ↓

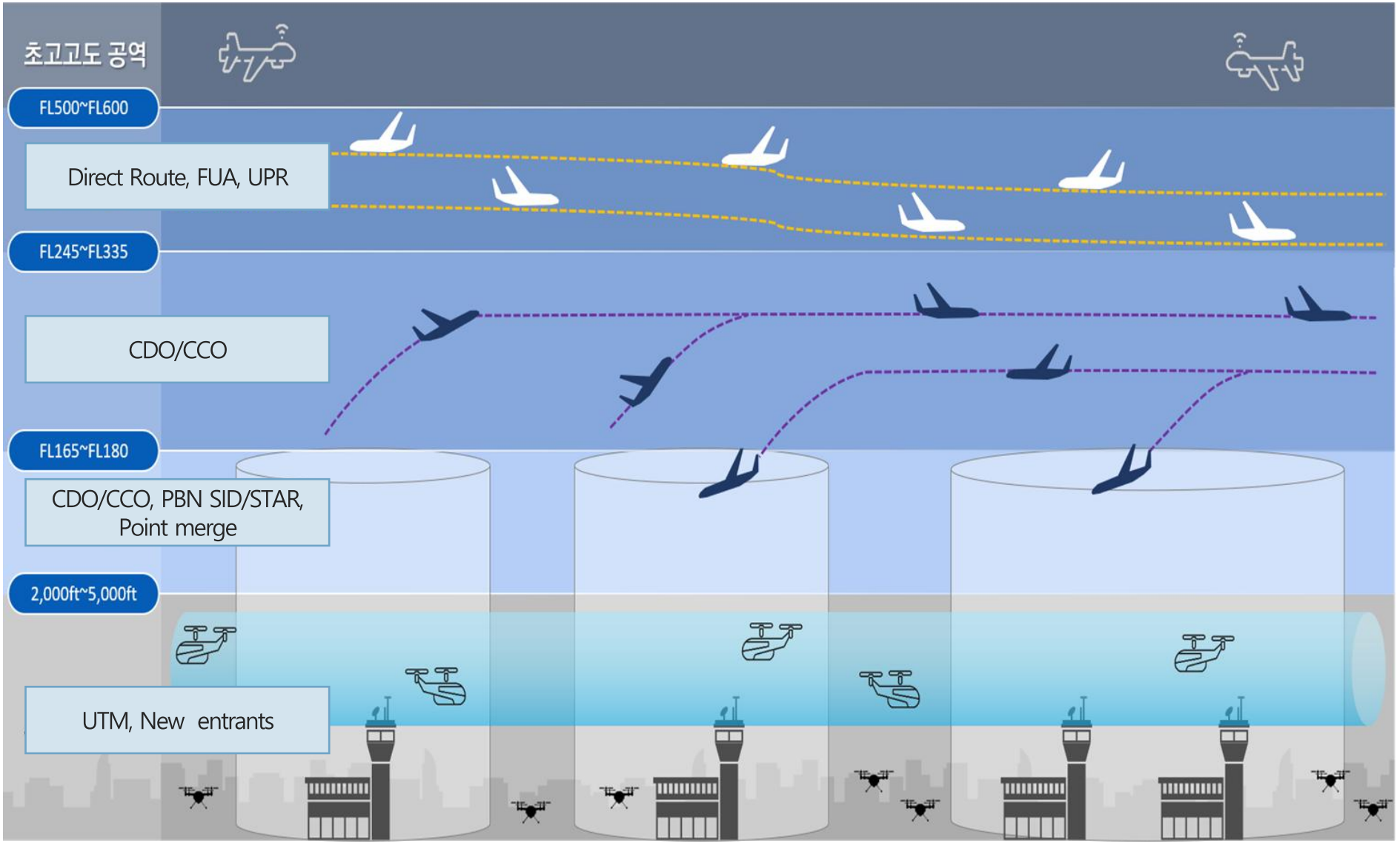
# 3. National ATM Reformation and Enhancement (NARAE)




※ Refer to ICAO TBO Application Concept

To enhance ATM operational efficiency, the implementation of Trajectory-Based Operations (TBO) is essential, which requires the execution of the relevant ASBU elements

## 3.1 Master Plan for NAS Development



# NARAE
# Vision and Improvement Targets

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## | VISION

**OPTIMUM FLIGHT which is seamless and safe via supporting data system**

## | Improvement Targets by Performance Area

| | Beginning(2019) | ~ 2024(Short-term) | ~ 2042(Mid-term) |
|---|---|---|---|
| Improve Flight Safety | # of ATC Incidents<br>0.446 case / 100 thousand | # of ATC Incidents<br>0.44 case / 100 thousand<br>(1.3%↓) | # of ATC Incidents<br>0.22 case / 100 thousand<br>(50%↓) |
| Increase Operation Efficiency | Domestic 63min,<br>International 97min | Domestic 62.7min,<br>International 96.7min<br>(Flight hours 0.5%↓) | Domestic 56.7min,<br>International 87.3min<br>(Flight hours 10%↓) |
| Increase Traffic Capacity | Total # of flights<br>840thousands | Total # of flights<br>840thousands<br>(Recovery of ATM air traffic volume) | Total # of flights<br>1690 thousands<br>(2 times of air traffic volume ) |
| Improve User Convenience | Departure 76.3%,<br>Arrival 76.1% | Departure 77%,<br>Arrival 77%<br>(Punctuality 1%↑) | Departure 92%, Arrival 91%<br>(Punctuality 20%↑) |
| Reduce Fuel Consumption | Annual average fuel consumption<br>7.17 tons / aircraft | 7.14 tons / aircraft<br>(Fuel Consumption 0.5%↓) | 20.3 tons / aircraft<br>(Fuel Consumption 11%↓) |
| Decrease in $CO_2$ Emissions | Annual average CO2 emissions<br>22.7 tons / aircraft | 22.6 tons / aircraft<br>(CO2 Emissions 0.5%↓) | 20.3 tons / aircraft<br>(CO2 Emissions 11%↓) |

# NARAE
# Vision and Improvement Targets



## | VISION

**OPTIMUM FLIGHT which is seamless and safe via supporting data system**

## | Results of Analysis by Performance Area

### Safety

- Throughput : Sharp drop in 2020 from 2019 levels, then a rising trend.
- Safety : Air traffic safety incidents have been rising steadily since 2021.

| Year | Throughput (10,000 flights) | Safety |
|---|---|---|
| 2019 | 84.2 | 0.237 |
| 2020 | 42.1 | 0.237 |
| 2021 | 46.5 | 0 |
| 2022 | 54.0 | 0.185 |
| 2023 | 78.1 | 0.512 |

### Punctuality

- Since 2020, as throughput increased, arrival and departure punctuality declined, but slightly recovered in 2023.

| Year | Dep Punctuality (%) | Arr Punctuality (%) |
|---|---|---|
| 2019 | 76.3 | 75.2 |
| 2020 | 79.6 | 75.0 |
| 2021 | 76.3 | 66.9 |
| 2022 | 71.6 | 63.4 |
| 2023 | 71.9 | 72.0 |

### Efficiency

- Domestic : Experiencing minor increases and decreases compared to 2019.
- International : Sharp drop in 2021, followed by growth from 2022 onward.

| Year | Dom Efficiency (min) | Int Efficiency (min) |
|---|---|---|
| 2019 | 63 | 97 |
| 2020 | - | - |
| 2021 | 65 | 78 |
| 2022 | 64 | 86 |
| 2023 | 64 | 88 |

### Environment

- Changes in fuel consumption and carbon emissions are identical.
- Shows minor fluctuations without a clear trend.

| Year | Fuel Consumption (ton/flight) | $CO_2$ Emissions (ton/flight) |
|---|---|---|
| 2019 | 7.17 | 22.7 |
| 2020 | 6.85 | 21.7 |
| 2021 | 7.05 | 22.3 |
| 2022 | 7.02 | 22.2 |
| 2023 | 6.97 | 22.0 |

## NARAE (National ATM Reformation And Enhancement)

### Tasks for Enhancing ATM Operational Efficiency

1. Flexible use of airspace through civil/military cooperation
2. Establishment of an operational concept for 4D trajectory
3. Increase of capacity via operational improvement
4. Optimization of ATM service by enhancing ATM functions

### Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

1. Establishment of a digital aviation information system
2. Establishment and Operations of SWIM
3. Data based ATM decision making support
4. Provision of remote ATM service based on AI

Safety ↑
Efficiency ↑
Punctuality ↑

Fuel Consumption ↓
CO2 Emissions ↓

# Tasks for Enhancing ATM Operational Efficiency

## 1 Flexible use of airspace through civil/military cooperation

**Needs**

- Inefficient Airspace Use due to many prohibited/restricted airspaces and separately operated Civil/Military airspace in ROK
- Collaborative use of airspace considered at a planning stage, fully understanding operational restrictions of airspace and preferred/requested airspace by its users

### 01 Flexible use of airspace

- In order to use limited airspace efficiently, cooperation has been enhanced between ATS centers and air forces such as Civil and Military airspace management team ('21~)

[ FUA Before/After ]


**[Enhancing Air Traffic Efficiency and Flight Economy]**

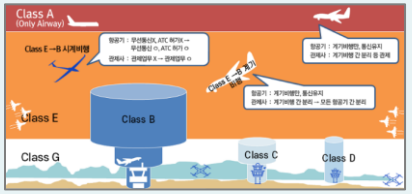

- Increased airspace capacity and reduced air traffic delays

- Reduction in distance, time and fuel

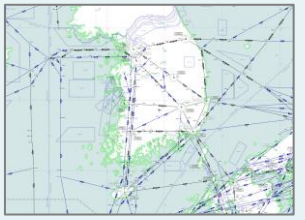
### 02 Sharing operational state of airspace

- With Enhanced cooperation between Civil and Military airspace management, National Airspace Integrated Management System (NAIMS) sharing plans for use of airspace has been vitalized and advanced('21~)
- (Benefits) Efficient operations via conditional route planning when capacity is expected to be exceeded.

**[Efficient and Flexible Airspace Management]**




- Optimizing airspace usage



- Enabling operations along optimal routes

## Tasks for Enhancing ATM Operational Efficiency

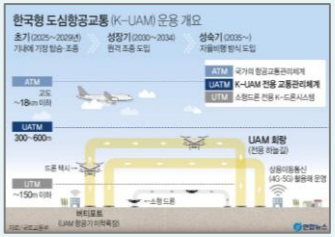
### 1 Flexible use of airspace through civil/military cooperation

#### 03 Adjustment of airspace in the capital area

- Hourly traffic capacity at Incheon airport has been increased by coordinating its airspace and improving DEP/ARR procedure with civil/military cooperation('21~)
- (Benefits) Expanding airport capacity to become a mega Northeast Asian hub handling over 100 million passengers per year.

**[Enhanced capacity and operational efficiency]**

- Increased airspace and airport capacity

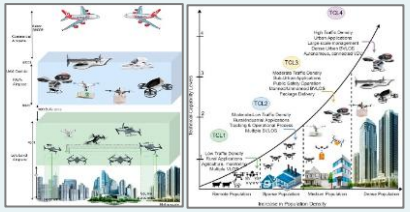



- Addressing future traffic demand (e.g., UAM)

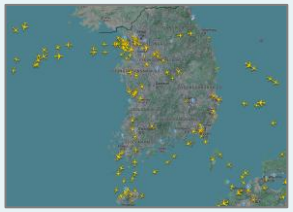
#### 04 Reassessment of the airspace system

- Comprehensive mid- to long-term revision of the national airspace system to meet growing air traffic demand and adopt new airspace management methods.('25~)
- (Benefits) Dispersing traffic through new route openings and shortening flight paths by utilizing high-altitude airspace.

**[Enhancing airspace efficiency and safety]**



- Optimizing airspace for new types of aircraft



- Enhancing safety through traffic distribution

## Tasks for Enhancing ATM Operational Efficiency

### 2 Establishment of an operational concept for 4D trajectory

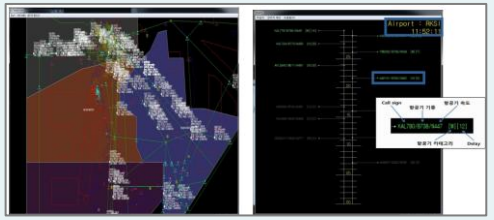
**Needs**

- Automation and systemization of DEP/ARR sequencing which has been currently made by controller's experience and ability
- Advancement and high predictability of AFTM via a decision support program and real-time information sharing
- Transition to 4D trajectory base

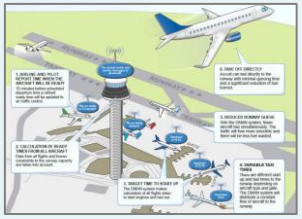
### 01 Advancement of surface management

- Introduction and application of time-based DMAN and AMAN to major airports considering ground movement, airspace situation, etc.( ~'24)
- (Benefits) Improved accuracy through system integration, enabling efficient decision-making, and reducing fuel consumption and flight time.

**[Enhancing efficiency in aircraft operations]**



- Enhancing aircraft operational efficiency in en-route and approach phases



- Increased accuracy of estimated departure and arrival times

### 02 Implementation of AIDC

- Expanding the ATS Interfacility Data Communication(AIDC) between neighboring countries such as Japan and China to the AIDC between the domestic control agencies (Area Control ↔ Seoul/Jeju App Control)( ~ '23)
- (Benefits) Enables automatic transfer of control authority between neighboring FIRs and approach control areas, simplifying coordination and reducing controller fatigue.

**[Enhancing air traffic control efficiency]**

- Simplifying air traffic control tasks


- Reducing fatigue through automated transfer of control authority

## Tasks for Enhancing ATM Operational Efficiency

## 2 Establishment of an operational concept for 4D trajectory

### 03 Improvement of ATFM

- System upgrades such as improving functions of automatic calculation and issuance of COBT/CTOT and developing a decision support program for flow management ( ~ '25)
- (Benefits) Enhancing safety and efficiency through optimization of the air traffic flow system, and advancing the realization of Trajectory-Based Operations.

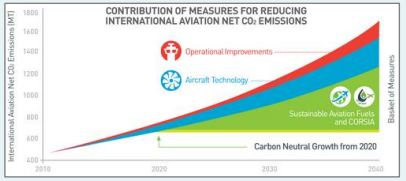

* Ref. ATCC K-ATFM Portal

**[Enhancing air traffic efficiency and reducing environmental impacts]**


- Prevention of airborne holding and ground congestion in advance

- Accurate flight timing information and operational decision support

- Prevention of Tarmac Delay




- Reduction of unnecessary fuel consumption and carbon emissions.

# Tasks for Enhancing ATM Operational Efficiency

## 3 Increase of capacity via operational improvement

**Needs**

- Probable to greatly reduce the air traffic delays due to increased capacity through minimizing the DEP/ARR intervals and improving runway occupation time and ground movement
- Increased runway capacity in the U.S. and Europe through Wake RECAT* as aviation technologies have been developed

### 01 Runway Occupancy Time Management

- Building a system for collecting, analyzing, and managing runway occupancy time (ROT), and continuing its management
- (Benefits) Improving runway occupancy management and capacity through data accumulation and regular analysis..

### 02 Advancement of A-SMGCS

- Incheon Airport A-SMGCS* has been upgraded to an integrated control system (iTWP)* by adding some additional functions such as ground movement clearance and warning control errors('21 ~ )
- (Benefits) Enhancing ground safety and improving airport operational efficiency.

* A-SMGCS(Advanced-Surface Movement Guidance and Control System)

** iTWP(Integrated Tower Working Position) : An integrated system that integrates manual operation tasks such as ground movement control instruction input and stop lines, and provides safety warnings regarding control errors, etc.

[A-SMGCS Configuration]


Follow the Greens　　Runway Incursion Alert

[ATC Instruction]

(Before): Korean Air 719, taxi via Romeo Charlie, Romeo one one.

(After): Korean Air 719, Follow the Greens.

[Impact of A-SMGCS]

- Taxiway entry errors at Incheon Airport reduced by 79.4%
- Taxiway movement time reduced by 38%
- Recognition of error prevention effectiveness: 90.8%

## Tasks for Enhancing ATM Operational Efficiency

### 3 Increase of capacity via operational improvement

#### 03 Recategorization

* RECAT(RE-CATegorization) : Separately from the current 4 categories regarding wake turbulence, the categories have been subdivided according to the weight of an aircraft and its wing span.

- Separately from the current four categories of wake turbulence separation, it has been subdivided into 7 categories considering aircraft weight and its wing span('21 ~ )**
- (Benefits) Real-time detection of wake turbulence and **wind shear enables aircraft**-type-specific separation, enhancing safety and increasing capacity at both airports and in airspace.

#### RECAT Pilot Operation at Incheon and Gimpo Airports

- RECAT was applied to arriving flights on the highest traffic day between May and October 2023.
- RECAT was applied and analyzed for 1,545 flights at Incheon Airport and 655 flights at Gimpo Airport on May 31, June 16, June 20, August 11, and October 11.

**[Number of RECAT-applicable cases]**

| Airport | RKSI | | | | | | RKSS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | B-B | B-D | D-B | D-D | etc | total | B-D | D-B | D-D | etc | total |
| Count | 334 | 310 | 364 | 423 | 114 | 1545 | 69 | 72 | 432 | 82 | 655 |
| Ratio | 21.6 | 20.1 | 23.6 | 27.4 | 7.4 | 100 | 10.5 | 11.0 | 66.0 | 12.5 | 100 |

- RECAT was applicable to **41.7%** of cases at Incheon Airport and **10.5%** at Gimpo Airport

## Tasks for Enhancing ATM Operational Efficiency

### 03 Recategorization

* Full implementation delayed due to missing ATC functions; trial operation extended.

| | RKSI | | | | | RKSS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Leading - Trailing | RECAT count | Current AVG. SEP. (NM) | Test AVG. SEP. (NM) | RECAT SEP. (NM) | Reduced SEP. (NM) | RECAT count | Current AVG. SEP. (NM) | Test AVG. SEP. (NM) | RECAT SEP. (NM) | Reduced SEP. (NM) |
| A-B | 8 | 6 | 4.80 | 4 | 1.20 | - | - | - | - | - |
| A-C | 1 | 6 | 5.54 | 5 | 0.46 | - | - | - | - | - |
| A-D | 5 | 7 | 6.04 | 5 | 0.96 | - | - | - | - | - |
| B-B | 9 | 4 | 3.74 | 3 | 0.26 | 1 | 4 | 3.89 | 3 | 0.11 |
| B-D | 55 | 5 | 4.42 | 4 | 0.58 | 28 | 5 | 4.57 | 4 | 0.43 |
| C-D | - | - | - | - | - | 2 | 5 | 4.56 | 3 | 0.44 |
| Total | 79 cases, 50.1NM flight distance Reduced | | | | | 31cases, 8.97NM flight distance Reduced | | | | |

- Out of applicable cases for RECAT (1,546 at Incheon, 656 at Gimpo), it was applied to 79 cases (5.1%) at Incheon and 31 cases (4.7%) at Gimpo.
- An annual flight time reduction of 22.7 hours (18.2h at Incheon, 4.5h at Gimpo)

The implementation of necessary systems* to expand coverage is expected to further enhance flight time reduction.

# Tasks for Enhancing ATM Operational Efficiency

## 4 Optimization of ATM service by enhancing ATM functions

**Needs**

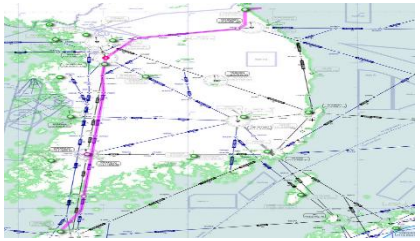
- Training with ATM simulators is critical as the long-lasting volume decrease of air traffic due to COVID-19 can degrade controllers' abilities.
- Not only controllers' abilities, but also capacity support system is required to cover the air traffic volume which will be recovered or increased after COVID-19
- An enhanced emergency response system is required to prepare for prolonged COVID-19 and emergence of new virus, and prevent manpower shortage due to controllers' infection

### 01 Expansion of CDRs

- More Conditional Airways (CDR 2, 3) to shorten flight routes while the military airspace is not being used such as for weekends and nights('21 ~ )
- (Benefits) Expanding direct routes and simplifying procedures to support airlines and reduce carbon emissions.

**[ Example of use in conditional Airways(CDR) ]**

RKPC → RKNY
350NM



RKPC → RKNY(CDR)
312NM

| Overview of Conditional Route (CDR2) in Korea | | | | |
|---|---|---|---|---|
| Route | RKTN → RKPC & SEA (MASTA → UPGOS) | SEA→Gyeongsang Region (RUGMA → ANROD) | RKSI → NA & Japan (KARBU → LANAT) | RKSI → SMA & South China (BOPTA → PONIK) |
| Operation Hours | Inactive Hours of MOAs(Weekdays 22:00–06:00 next day, full day on weekends and public holidays) | | | |
| Designation History | Pilot: Jun. 2021<br>Full: Sep. 2022 | Pilot: Jun. 2021<br>Full: Oct. 2023 | Pilot: Oct. 2023<br>Full: Dec. 2024 | Pilot: Oct. 2023<br>Full: Dec. 2024 |

## Tasks for Enhancing ATM Operational Efficiency

### 01 Expansion of CDRs

- In 2024, a total of 29,167 flights operated under Type 4 Conditional Routes (CDR2), averaging approximately 80 flights per day.
- 13,471 flights from Incheon to Southeast Asia and South China used CDR2, followed by 11,603 flights on Incheon–Americas/Japan routes, 2,323 on Southeast Asia–Gyeongsang region routes, and 1,770 on the Daegu–Jeju route.

[Operational Benefits of CDR2 in 2024]

| | Distance | CO2 Emissions | Fuel Burning | Fuel Cost |
|---|---|---|---|---|
| Total Reduction | 236,569NM | 21,568.8t | 6832.1t | KRW 7,568,032,552 |
| Average Daily Reduction | 646.4NM | 58.9t | 18.7t | KRW 20,677,685 |
| Reduction per flight | 8.1NM | 700kg | 234.2kg | KRW 259,472 |

- In Q1 2025, 53,259 out of 190,999 international flights used shortened routes.

[Operational Benefits of CDR2 in Q1 2025]

| | Distance | CO2 Emissions | Fuel Burning | Fuel Cost |
|---|---|---|---|---|
| Total Reduction | 480,000NM | 14,217t | 4,503t | KRW 4,600,000,000 |
| Average Daily Reduction | 5333.3NM | 158.0t | 50.0t | KRW 51,111,111 |
| Reduction per flight | 9.0NM | 267kg | 84.5kg | KRW 86,370 |

## Tasks for Enhancing ATM Operational Efficiency

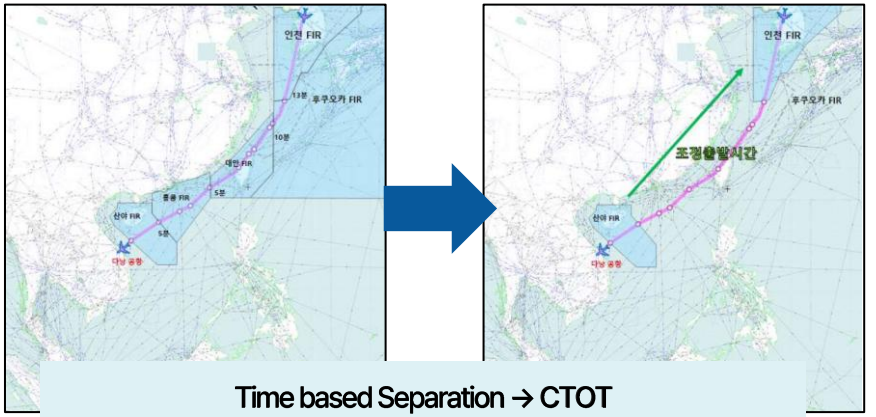
### 02 Minimization of ATFM

- Minimizing unnecessary flow management by strengthening cooperation between neighboring countries (China, Japan) in order to recover the air traffic volume quickly after COVID-19( ~ '23)
- (Benefits) Strengthening cooperation to minimize restrictions, optimize flow management, and increase airspace capacity.

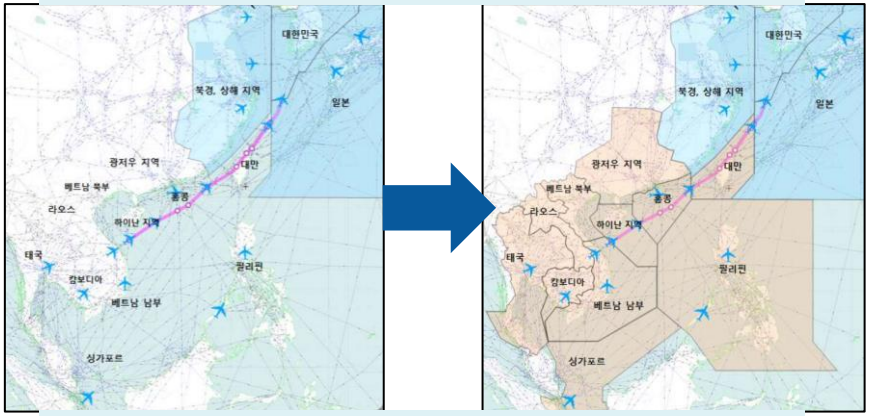
- By assigning CTOTs based on destination and airspace conditions—instead of applying separation by each country's ATC—unnecessary delays are reduced and efficiency is improved.

- Since August 2023, the Korean and Vietnamese aviation authorities have cooperated to reduce average delays for Da Nang flights by over 70%(11min/flight → 3min/flight), saving KRW 145 million in annual fuel costs.
- AMNAC membership is expected to expand ATFM coverage to over 76.6% of international flights (+31.1%), improving efficiency.

[Offical Membership in AMNAC]




Time based Separation → CTOT



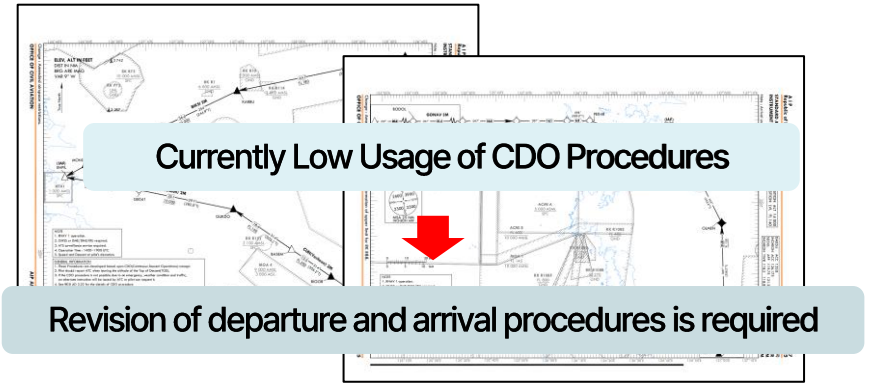

Flow Management Coverage expanded from 45.5% to 76.6%

# Tasks for Enhancing ATM Operational Efficiency

## 03 Expansion of CCO/CDO

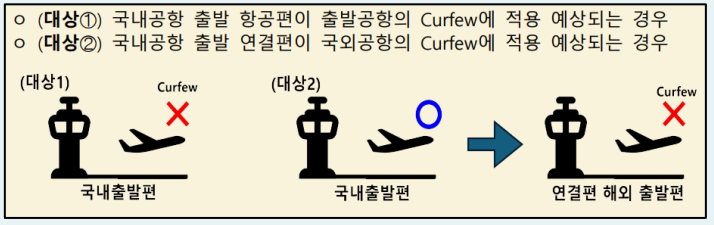
- Transition to a continuous climb/descent operations (CCO)/(CDO) at an optimal angle from the existing terraced Climb/Descent( ~ '24)
- (Benefits) Enhanced fuel efficiency, lower carbon emissions, and reduced communication through continuous climb and descent.

  - The only CDO procedure currently in operation in Korea is at Incheon International Airport, applied to flights arriving via Y644, Y722, G585, and G597, and landing on runways 33L/R between 23:00 and 04:00.
  - The current CDO procedure is seldom used due to complex airspace, and no CCO/CDO procedures exist at other airports—highlighting the need for improvement.




## 04 Prevention of Diversions due to Curfews

- Direct flight and other active controls to reduce the number of diversions due to airport noise restrictions (Curfew, ex. Gimpo/'23:00 to 06:00 on the day)
- (Benefits) Reducing diversions to Incheon to lower airline costs and enhance passenger satisfaction.




[Curfew-Affected Flight Priority Allocation Procedure]

Curfew-expected flight identified → Airline reviews internal measures* → If none, submit Request procedure → Priority allocation granted → Post-review conducted

- Airlines can request priority if a flight may be delayed by the curfew → ATFMC supports timely departures and arrivals before curfew through take-off time adjustments or priority assignment
- Pilot Operation Outcome: In Q3 2024, the procedure was applied to 6 flights expected to be affected by the curfew.

Expected to prevent approximately KRW 30 million in economic loss per flight for airlines.

## Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

### 1 Establishment of a digital aviation information system

**Needs**

- Transition to the electronic Digital Aeronautical Information Management(DAIM) from the existing analog methodology in response to the dramatic increase of air information collected and produced
- Integrated management to improve the reliability and efficiency of flight plans which are currently managed separately by each control unit and airline

#### 01 Electronic Aeronautical Information

- Continuing and upgrading the established Digital Aeronautical Information Management(DAIM) with promoting development to enable interworking and information exchange (AIXM)('21~)
- (Benefits) Establishing an AIXM-based system to support aeronautical information exchange through SWIM, as recommended by ICAO standards.

#### 02 Integrated Management of Flight Plans

- Improving predictability of traffic volumes by establishing an information sharing system (FF-ICE) such as digitalization of information sharing between control units and integrated flight plan management.('22~)
- (Benefits) Enhancing integrated flight operations, and enabling SWIM-based information exchange, the system ensures accurate traffic prediction, reduces controller workload, and supports a reliable and global ATM environment.

## Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

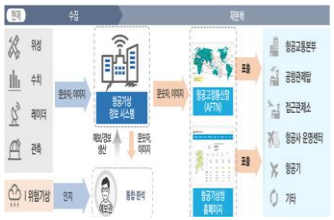
### 1 Establishment of a digital aviation information system

#### 03 Digital-based Meteorological Information

- For integration with the ATM System, converting the weather information in the form of text and images into digital-based four-dimensional information.('22~'26)
- (Benefits) Improved meteorological services—such as customized weather information based on flight phases and user requirements—enhance the safety and efficiency of air traffic operations.

Main tasks

[ Future WX service comparison ]

| As-Is | | To-Be |
|---|---|---|
| Producing scheduled time | INFO' production | produce by user's demand |
| 2~3D | Type of provision | 4D(Lat, Lon, Alt, Time) |
| IMG, TEXT | | Grid, XML, IMG available to be integrated on user's system |
| Limited adverse WX INFO' | Contents | Detailed adverse WX INFO' for decision making |
|  | Delivery system ⟷ Comparison of before/after the flexible use of airspace |  |

## Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

### 2 Establishment and Operations of SWIM

**Needs**

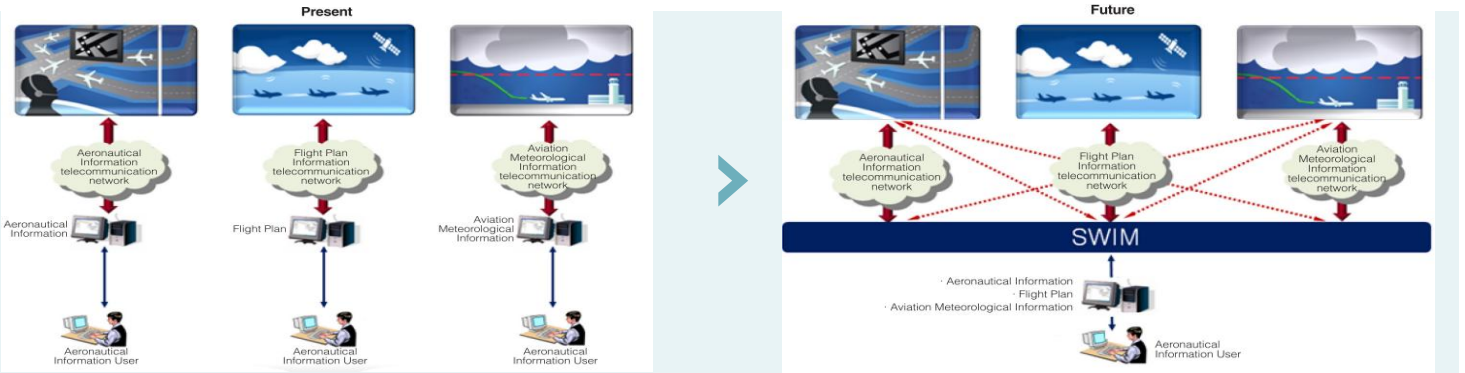
- The U.S and Europe have continued R&D to establish a user-centered SWIM, and ICAO recommends that SWIM be included in a mid to long term plan for each country
- Systems regarding comprehensive management of aeronautical information have also been developed in Korea, but fundamental design and establishment of SWIM based on network is needed.

* SWIM(System Wide Information Management) : Next-generation information infrastructure that shares air traffic management (ATM) information among stakeholders around the world through standardized formats

#### 01 Establishment and Operations of SWIM

- Development of SWIM promoting shareholders to share information on air navigation and aviation
  - Participating in such groups like ICAO SWIM task force ('17~'), monitoring study group(SURSG, '21~') to enact international technology standards, and promoting step-by-step construction and transition utilizing the standards ('21~25)
- (Benefits) Reduced communication line costs and improved scalability for line expansion

[ Before/After Introduction of SWIM ]



## Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

### 3 Data based ATM decision making support

**Needs**

- ICAO recommends to apply a data-based scientific approach to the establishment of ATM policies in order to handle traffic volumes with limited infrastructure
- Analysis of factors on ATM performance vulnerability based on air traffic data with the establishment of a system utilizing the analysis for goal management

### 01 Air Traffic Data Platform/Center

- Establishment of a platform where air traffic operators (Airlines, Airport corporation, and Control units) can jointly store and utilize data( ~ '24)
- (Benefits) Reduces delays and increases ATC capacity, generating economic benefits.

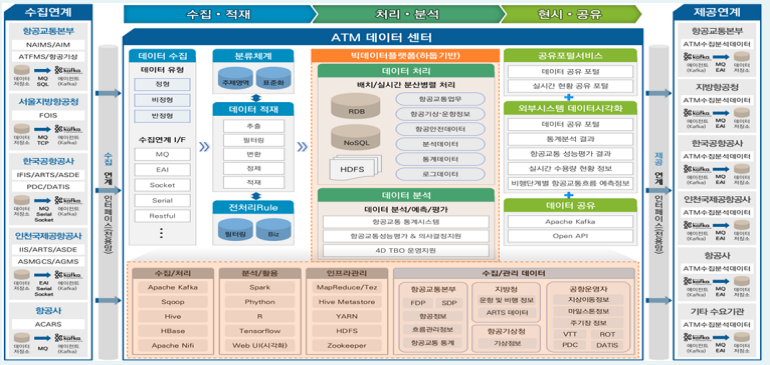
### 02 ATM Decision Making Support System

- Establishment of a support system analyzing the interconnection within influential factors of ATM scientifically and system-dynamically
  - Development of core operational technologies such as data-based ATM performance evaluation and operational analysis, capacity prediction, and 4D trajectory-based flow management( ~ '25)
- (Benefits) Improve efficiency, reduce delays and workload, and enable safer trajectory-based operations.

### 03 Airport Management Platform

- Establishment of an Integrated Airport Operation Platform based on Data and a Collaborative Center for making decisions and controls( ~ '23)
- (Benefits) Data analysis and prediction across all stages enable optimized passenger flow and reduced waiting times, laying the foundation for personalized services.

[Construction of Air Traffic Data and Operation Concept of Data Center]



## Tasks for Building Systems/Infrastructure Supporting ATM Efficiency

### 4 Provision of remote ATM service based on AI

**Needs**

- AI, XR(Extended Reality) and other technologies should be developed allowing control services anywhere regardless of physical location of manpower/equipment
- ICAO recommends remote controls in small airfields with low-cost efficiency, compared to installation and operation of control towers

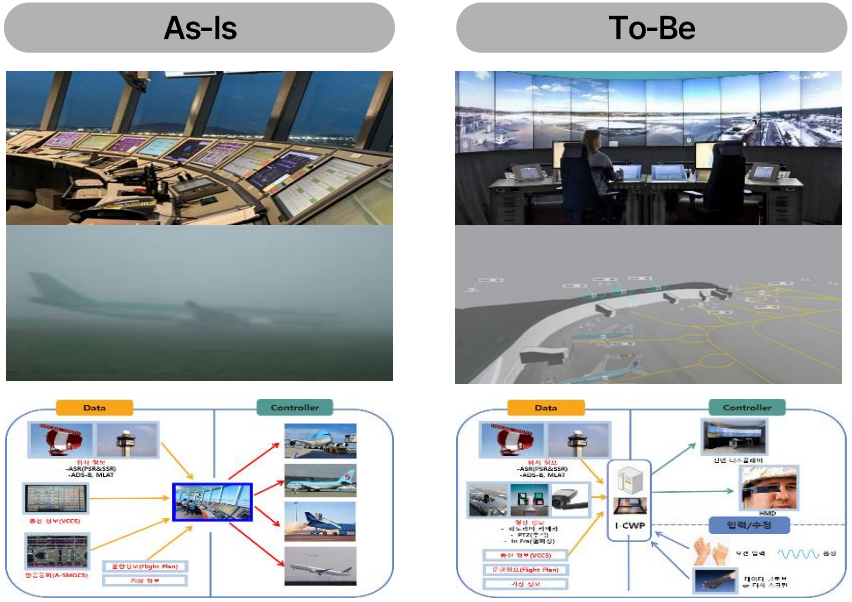
#### 01 AI Remote Tower Technology

- Development of remote-control service technology that integrates AI·XR and digital twin enhancement and implementation of remote controls in an airport('22~)
- (Benefits) Improving visibility, monitoring high-risk areas, and establishing remote ATC for island regions.

#### 02 Establishment of ICWP

- Integration of various control equipment interfaces (systems, user interfaces) to a platform for improvement of control concentration and awareness
  - Review to standardized the customized control systems for each airport with AR/VR control platforms and an environment removing any objects blocking the view('22 ~)
- (Benefits) Reducing blind spots and human error in multi-equipment operations.

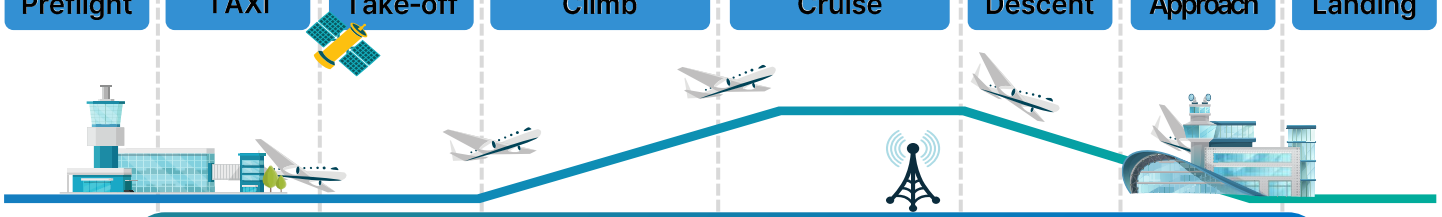
[AI Remote Control Technology and Smart Integrated Control Platform]



# IV NARAE Desired Effects

MOLIT Ministry of Land, Infrastructure and Transport

| Preflight | TAXI | Take-off | Climb | Cruise | Descent | Approach | Landing |
|---|---|---|---|---|---|---|---|



Data and system support ensures "optimal seamless and safe flight paths"

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Establishment of integrated management system for Flight ·Aeronautical · Meteorological information | Advancement of functions for A-CDM, A/D-MAN | Advancement of SIP based on PBN | Expansion of CCO/CDO | Expansion/proceduralization of direct routes | Expansion of CCO/CDO | Advancement of SIP based on PBN | Advancement of A-SMGCS , Aeronautical lighting system |

**Flexible airspace operations with civil, military and international cooperation**
- Reinforcement of the FUA with civil, military, and government cooperation
- Reformation of the NAS and integrated operations of Korean, Chinese, and Japanese airspace
- Minimize ATFM between adjacent countries
- Establishment of the information sharing system on the use of Civil and Military airspace(NAIMS vitalization)

**A-CDM Establishment · Connection**
- Expansive · Advancement of A-CDM

**DEP/ARR management**
- Establishment Aircraft DEP/ARR Management system
- Minimize diversions due to Curfews
- ATFM improvement by MDI minimization

**Increase in Runway Capacity**
- Working on the scientific wake turbulence criteria with considering characteristics of airports·aircraft
- Advancement of time-based wake turbulence separation
- Runway occupancy time management

**Advancement of A-SMGCS**
- Establishment of iCWP in ICN
- Establishment ON BOARD guidance system
- Expansion to GMP · CJU · PUS

**Establishment of 4D TBO system**
- Establishment of ADC
- Advancement and Linkage of ATFM

**Digitalization of Aviation Information**
- Advancement of E-aviation information management system
- SWIM protocol development and operations
- Smartization of WX information

**Establishment of GADSS**
- Establishment of a web-based information sharing system
- Establishment of a national SAR plan

**Construction of a New vehicle traffic management system**
- Korean UTM reinforcement
- Developing the concept of UTM and implementing initial functions

**Construction of a digital based Air traffic system**
- Construction of air traffic data platforms and operating systems
- Establishment of an integrated data-based airport operation management platform
- Construction of a ATM decision support system
- AI remote control technology development
- Construction of a smart integrated control platform

**High-tech and standardized NAVAIDs**
- AeroMACS Design and Demonstration
- Establishment of CPDLC
- Construction of next-generation air communication network (CRV) based on Internet protocols
- Development of Korean SBAS, Korea Augmentation Satelite System(KASS)
- Consideration of introducing GBAS
- Advancement of domestic airspace and Terminal Control Area(TMA) monitoring systems

**Control capacity enhancement**
- Expansion of Control simulators
- Ability-based Education and Training System EHDLQ
- Introduction of an AI-based Voice Recognition System
- Expansion of E-strips
- Reinforcement of quarantine and emergency response systems

**Management of NARAE implementation**
- Establishment of NARAE management system
- Aviation safety law renewal
- Activating the NARAE Promotion Committee
- Enhancement of the comprehensive SP function

## Economic benefit from the decrease in delays and operation time

**Short term(~'24)**

$24.3 million

Operational cost reduction (Airline) $21.1 million

Operational profit increase (Airport) $3.2 million

**Mid term(~'30)**

$71.1 million

Operational cost reduction (Airline) $619.7 million

Operational profit increase (Airport) $91.8 million

**Long term(~'42)**

$10 billion

Operational cost reduction (Airline) $8.7 billion

Operational profit increase (Airport) $1.2 billion

* Indirectly made Benefits such as National/ Logistic industry benefits via Delay Reduction and additional revenue from increased Airline Sales are not reflected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Infrastructure and Transport
Thank You
National ATM Reformation And Enhancement