ATM Research in Japan

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Yutaka Fukuda

Japan Civil Aviation Bureau (JCAB)
CARATS R&D Sub-Committee

Air Traffic Management Department
Electronic Navigation Research Institute
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CARATS: Collaborative Actions for Renovation of Air Traffic Systems

“CARATS Progress Report 2011-2013” will be published soon.

Slides of CARATS are by courtesy of Japan Civil Aviation Bureau
For effective and efficient work on our future ATM systems, we need,

1. **Collaboration** among industry, academia and government;
2. **Collaboration** between operators and air navigation service providers;
3. International **collaboration** to realize seamless air traffic;
4. **Collaboration** among co-users of air space (Civil, Military); and
5. **Collaboration** with local communities
Outline of CARATS

Goals setting toward 2025

1. Enhance safety
   5 times Safety
2. Increase ATC capacity
   Double Capacity
3. Improve user convenience
   +10% Service level
4. Efficient Operation
   -10% Fuel Consumption
5. Enhance ATM service efficiency
   +50% Productivity
6. Respond to Environmental issue
   -10% CO2 emission
7. Strengthen International Cooperation

Eight Pillar of Renovations

- Trajectory based Operation
- Enhance Predictability
- Performance base Operation
- Satellite based Navigation
- Improve Situational Awareness
- Automation System and Human Information Sharing & CDM
- High Density Operation

Realizing the renovation

Lay out a roadmap, representing step-by-step implementation of the measures required to build the future air traffic systems.

Clarify the roles of the industry, academy and government partners.

Consider and set index for achievement analysis of numerical goals.
To develop future ATS in organized manner based on the Long-term Vision, we established CARATS roadmap in March 2011 by working with related stakeholders.

- We clarified 55 measures to achieve the Long-term Vision.
- We grouped the 55 measures into Operational Improvements (OIs) and their Enablers (ENs).

Legend of CARATS roadmap

- Preparation for Implementation (Measures can be implemented after this period)
- Research and Development other related activities need to be done before implementation decision making.
- Implementation Decision Making
- Implementation Decision Making (with two or more directions)
- Already operated policy
- Measures that is not clarified as OI/EN yet and will be studied further.
ACC controls time of passage over each fix, streamline air traffic flow, and avoid traffic concentration. At first, time-based management will be applied to domestic flight arriving to busy airports.

- Evaluating effects with ENRI now.
Implemented RNAV/RNP procedures for departures, arrivals and approaches

<table>
<thead>
<tr>
<th>SID/TR (Departures)</th>
<th>STAR (Arrivals)</th>
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<tbody>
<tr>
<td>RNAV1: 30</td>
<td>RNAV1: 26</td>
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<tr>
<td>Basic-RNP1: 5</td>
<td>(# of Airports)</td>
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<td>(# of Airports)</td>
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Approaches

- RNP Approach: 15
- RNP AR Approach: 10
- RNAV(GNSS): 16
  - (# of RWY Ends)

Sample of flight path (Odate-Noshiro Airport: RNP AR approach)

- By utilizing improved precision of aircraft navigation performance and precise airborne equipment, we introduce RNP AR approach procedures allows efficient and flexible routing.
- Assumed benefits are reduced route expansion, higher airspace capacity, and noise abatement.
• Trajectory-based ATM Operation
  – 4DT Concept applied to Japanese airspace

  - Treat the whole airspace as an airspace and optimize the trajectory from departure to arrival
  - Attain flexible trajectory requested by operator
  - Achieve efficient descent and high-density operation in congested airspace
  - Minimized delay due to coordinated trajectory adjustment prior to departure
  - Fly smoothly on a pre-adjusted trajectory from departure to arrival
  - Integrated ATC data processing system

• SWIM: System Wide Information Management
  – Steps towards gradual implementation

• Data-link communication
  – Air-to-ground Data-Link in continental airspace
ENRI, JAXA and manufacturers have been main R&D stakeholders in Japan.

There are very few university researchers.

ENRI, JAXA and other research institutes

Civil Aviation Bureau

Operators

Research on a wide range of basic technologies

Presenting practical needs
Provides navigation data

Research exchanges
Mutual exploitation of research facilities

Universities
Sub-committee for Promoting Research and Development

Sample issues:

- Limited human resources of research institutes
- Research funding for universities
- University education in ATM field
- Consolidation of aviation-related manufacturers’ opinions
- Providing air navigation system data or operational data for research purposes
- Cooperation with other countries’ research institutes
Japanese R&D Organizations

Government Research Organizations

- MLIT (Ministry of Land, Infrastructure, Transport and Tourism)
  - JCAB (Japan Civil Aviation Bureau)
- MEXT (Ministry of Education, Culture, Sports, Science and Technology)
  - JAXA (Japan Aerospace Exploration Agency)
  - ENRI (Electronic Navigation Research Institute)

Universities

- Tokyo University
- Nagoya University
- Tokyo Inst. Tech.

Industry

- NEC
- NTT Data
- Mitsubishi Electric
- Toshiba
- Oki Electric Industry
- Japan Radio Co.
- Etc.
ENRI is responsible for research and development in the field of ATM in Japan
- Established in 1967 as a national laboratory
- Budget: 1.6 billion yen (FY2013)
- Personnel: 65 (47 researchers)

Major Research Areas
- Air Traffic Management
- Navigation systems
- Surveillance and Communication
- [http://www.enri.go.jp/eng/index_e.htm](http://www.enri.go.jp/eng/index_e.htm)
Trajectory Based Operations

• Full 4D TBO concept creation
• Trajectory Predictor development

Airport Operations

• Airport Surface Movement Simulator
• Scheduling methods to alleviate airport surface congestion
Oceanic Route Optimization

Optimization of Oceanic Track System including Arrival Route with CDO

Aircraft Surveillance Applications System (ASAS)

• Joint Airborne time-spacing Design Evaluation (JADE)
• Aircraft Surveillance Applications System (ASAS), Interval Management (IM)
ATM Research Topics (3)

ATM Performance estimation
• Current Japanese ATM performance measurement
• Performance estimation of new measures

Development of Process Visualization Tool of ATC Tasks (COMPASi)

• Improvement of controller training
• Evaluation of new air traffic management system and procedures
Communication Research Topics

Aeronautical Mobile Airport Communication System (AeroMACS)

Development of experimental 5 GHz (C-band) prototype with MIMO antenna system

Future Aeronautical High Speed Data Links

Evaluation of emission quality and data transmission performance of new data links (e.g. L-DACS)

L-DACS : L band Data link Aeronautical Communication System
MIMO : Multiple-Input Multiple-Output
Navigation Research Topics

GBAS Ground Based Augmentation System

Japanese-developed CAT-Ⅰ GBAS system with Ionosphere field monitor

- CAT-Ⅲ GBAS (GBAS Approach Service Type D (GAST-D))
- Landing Procedures of Precision Approach along Curved Path

GBAS facility and Boeing 787 at Kansai Airport

Ionosphere Density (12JST)
Hybrid Surveillance Technology
• Data Integration of conventional and new system
• Wide Area Multilateration (WAM) system
• Automatic Dependent Surveillance—Broadcast (ADS-B)

Advanced En-route Surveillance
Foreign object debris (FOD) detection
Millimeter wave radar
90GHz linear cell
Main Facilities

Experimental Aircraft

King Air 350

Radio Anechoic Chamber

Experimental Mode-S Radar
International Collaboration

♦ Joint research between International ATM/CNS research institutes and Japan
  - NLR, NASA, ENAC, University of Nice-Sophia Antipolis, KARI, KOTI, KAU, etc.

♦ ENRI International workshop on ATM/CNS (EIWAC) 2013
  - ICAO, FAA, DSNA, DGAC, AAPA, IATA, NASA, etc.
  - 500 Participants (foreign 80)
  - 43 Presentations (foreign 28)

KARI: Korea Aerospace Research Institute
KOTI: Korea Transport Institute
KAU: Korea Aerospace University
AAPA: Association of Asia Pacific Airlines
Conclusions

♦ CARATS, JCAB long-term vision
  ■ Eight Pillar of Renovations on ATM/CNS
  ■ CARATS road maps to realize the concepts
  ■ Sub-committee for Promoting Research and Development

♦ ENRI major research topics on ATM/CNS
  ■ TBO, Airport operation, Oceanic Route Optimization, ASAS, ATM performance, Visualization Tool of ATC Tasks
  ■ High Speed Data Links, GBAS, Hybrid Surveillance, FOD detection

♦ ENRI is contributing to CARATS in both near and long term basis.