R & D Activities in Japan for Improved Air Traffic System
（航空管制システム変革のための我が国における研究開発）

- For Promoting Carbon Neutral Growth -

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1. What is ENRI?

- **Electronic Navigation Research Institute**
- Established in 1967 as a national laboratory
- Major research fund comes from Ministry of Land, Infrastructure, Transport & Tourism
- Budget: ¥1.8 billion ~ $16 million (2014, including personnel cost)
- Personnel: 63 (44 researchers)


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◆ Major research areas
  ➢ ATM (Air Traffic Management)
  ➢ Navigation systems and its operation
  ➢ Surveillance, Communication & Avionics

◆ Major roles of ENRI
  (1) *Improvement* of present CNS/ATM Systems in Japan operated by JCAB
  (2) *R, D and Test for future aviation systems*
  (3) *Contribution to establishing technical standards for future aviation systems*
Facilities

- Radio Anechoic Chamber
- Experimental Aircraft (KingAir 350)
- Experimental Mode-S Radar
An advantage of ENRI

Many collaborators in the world (~40)

a. University of Nice-Sophia Antipolis
   - Precision radar systems
   - PhD education

b. NASA
   - Flight safety study

c. Korea Aerospace Research Institute
   - GNSS landing system

d. Kyusyu University
   - Optimum flight trajectory

e. Ministry of communication
   - New Generation Communication System
2. Air Traffic: Today and near future

- **Big traffic increase** in airspace/airport
- **More competitive environment** by **LCCs, Bullet Trains**
- **Convenient and Quality Service**
- **Reduction of operation cost**
- **Reduction of environmental impact**
- **Safety is the First!**

*Above is true all over the world!*
Major projects going in the world - Taking into account present air traffic ... 

NextGen* SESAR** and CARATS***

- Time Based Operation: Initial 4D; full 4DT*4
- Wide Area Data Link: CDM; SWIM*5
- Satellite Based Navigation: GBAS, SBAS
- Enhanced airborne system: ADS-B; ASAS

* Next Generation Air Transportation System
** Single European Sky ATM Research
*** Collaborative Actions for Renovation of Air Traffic Systems
*4 Four Dimensional Trajectory based operation
*5 System Wide Information Management
Full 4DT?, SWIM?

- Business Trajectories
- Safe & Smooth Merging
- Limited space & time
- Timely trajectory update
- Separation assurance

- Information exchange
- Air & Ground data link

- Strict time based operation as train diagram

- A set up to share operation information with all the parties concerned
ICAO “Global Air Navigation Plan” and “ASBU”

ICAO ASBU*

(1) Airport operation,
(2) Globally Interoperable Systems & Data,
(3) Optimum Capacity and Flexible Flights,
(4) Efficient Flight Path.

*Aviation System Block Upgrade
3. Major R & D Activities in ENRI

(1) Efficient Ground traffic

◆ Airport surface traffic management

ENRI has been analyzing Haneda and Narita airport traffic to locate traffic bottleneck

From the airport traffic data, “Surface Trajectory Simulator” has been developed

Block-out time management is effective to mitigate congestion

We are developing Smart Surface Management!
(2) Efficient landing

◆ Development of Prototype GBAS and new operation procedures for GBAS

Our GBAS has a feature of Ionosphere Interference tolerance

Accuracy, availability and reliability were tested at Kansai and Ishigaki Airport

Approach paths generated by ILS and GBAS has been compared by B787 flight simulator

Better path alignment by GBAS than by ILS based approach

Safe and efficient landing can be attained by GBAS!
(3) Runway throughput improvement

- Millimeter wave radar network system

ENRI has been developing a world first optical fiber based millimeter wave radar network for airport foreign object detection.

Coverage, Accuracy, Reliability and Cost are evaluated.

Basic performance has been demonstrated!
(4) Increased **Interoperability, Efficiency and Capacity**

- **Mini-Global Demonstration (MGD)**

  MGD is a project to demonstrate the environment of flight and flow information sharing and the utility of SWIM.

  ENRI has become a member of the demonstration group and prepared a scenario of oceanic flight to and from Japan.

**Demonstration has been a great success!**
(5) Efficient ground traffic data sharing

- **Aeronautical Mobile Airport Communication System (AeroMACS)**

  AeroMACS is a new generation high speed Air and Ground data link based on MiMAX (IEEE 802.16) technology

  ENRI has developed **a world first prototype** for evaluation

  The prototype has satisfied design specification!
(6) Optimum **Capacity and Flexible Flights**

**Application of Interval Management (IM)**

IM is an ASAS* Application. In IM, aircraft keeps separation with each other by its ASAS capability.

**ATCO takes that role now!**

ENRI is analyzing the possibility of introducing IM in Tokyo terminal air

**SPICA**** Simulator has been developed for the analysis**

* Aircraft Surveillance Application System
** Spacing time Intervals of arrival aircraft Conducting ASAS IM

Feasibility of ASAS and normal flight merging has been demonstrated
(7) Optical fiber based surveillance

- **Development & test of OCTPASS**
  OCTPASS is an optical fiber based aircraft locating system using Multi-lateration technology.

Performance test was conducted at Sendai Airport.

Interference tolerable, accurate and competitive cost. Coverage has been extended to Terminal area!
(8) Efficient & environment-friendly operation

◆ RNP-AR* operation Performance and Safety

ENRI has been analyzing the validity of RNP-AR operation in Japanese Airports and its safety.

* RNP Authorization Required

Performance indices:
Course flexibility, Environmental impact, Flight time reduction, Capacity
Safety estimation for RNP-AR and normal mixed operations

Less flight course and time uncertainty, Separate analysis by each airport is necessary
4. Other Challenges for future air traffic systems in Japan (1)

(1) Impact of wake vortex turbulence

ENRI and JAXA are now cooperating to predict the impact of wake turbulence on approaching aircraft.

- Wake turbulence measurement technologies
- Visualization of turbulence
- New GBAS operation to mitigate the impact
- Modification of present wake turbulence separation rules
Other Challenges in Japan (2)

(2) Unmanned Aerial System (UAS)

Many organizations including ENRI, JAXA are now working hard to enable practical UAS operations

✓ Co-existence of manned aircraft and UAS in airspace
✓ Dependable UAS and ground communication link
✓ Sense and Avoid of flight obstacles

(3) ATCO task analysis

ENRI and some universities are now collaborating to develop ATCO’s workload estimation tool

✓ Empirical based task analysis and classification
✓ Visualization of the results for workload estimation
✓ Application of the tool to ATCO training
5. Conclusions

- What is ENRI?
- What is going on in present aviation society?
- ICAO GANP, NextGEN, SESAR and CARATS
- Major R & D projects and results in ENRI
- Some other important R & D topics

Anticipation is a key feature for ENRI to exist as global performance!