

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 -

Kazuo YAMAMOTO

***Electronic Navigation Research Institute
(ENRI, Japan)***



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)

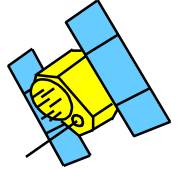
<http://www.enri.go.jp/index.shtml>

Address: 2-24-6 Jindaiji Higashi-machi, Chofu, Tokyo 1820012



◆ Major research areas

- **ATM** (Air Traffic Management)
- **Navigation systems** and its operation
- **Surveillance, Communication & Avionics**



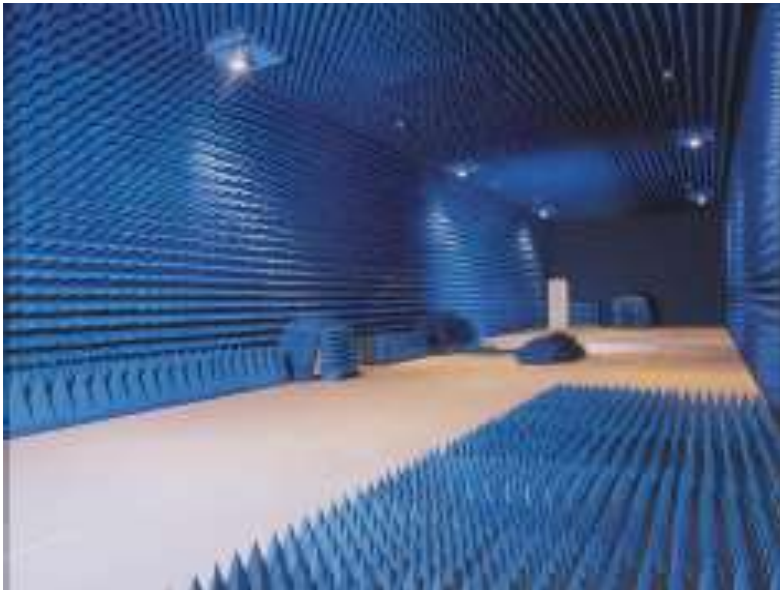
◆ Major roles of ENRI

- (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 Mode-S Radar



➤ Experimental Aircraft



◆ *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**



九州大学
KYUSHU UNIVERSITY

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 ...



* Next Generation Air Transportation System



➤ **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**

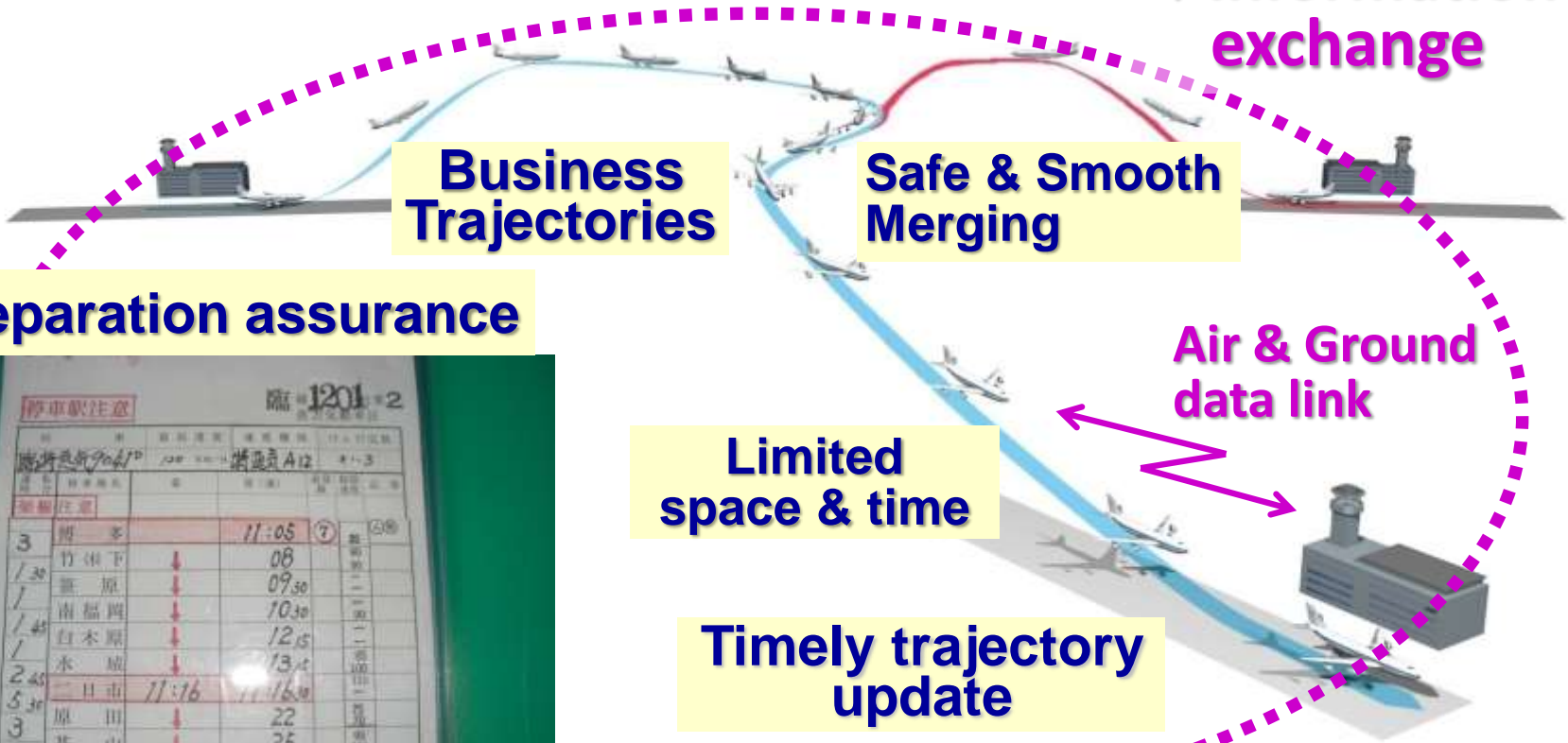
** Single European Sky ATM Research *** Collaborative Actions for Renovation of Air Traffic Systems

*4 Four Dimensional Trajectory based operation *5 System Wide Information Management



◆ Full 4DT?, SWIM?

◆ Information exchange



Separation assurance

列車種別	発着	停車	時刻	備考
3	博多		11:05	?
1/30	竹田下	↓	08	
1	熊原	↓	09:30	
1/45	南福岡	↓	10:30	
1	白木原	↓	12:15	
2/45	水城	↓	13:15	
5/30	日市	↓	11:16	
3	原田	↓	22	
3	基山	↓	25	
3	田代	↓	28	
2	鳥栖	↓	11:30	(11:31)

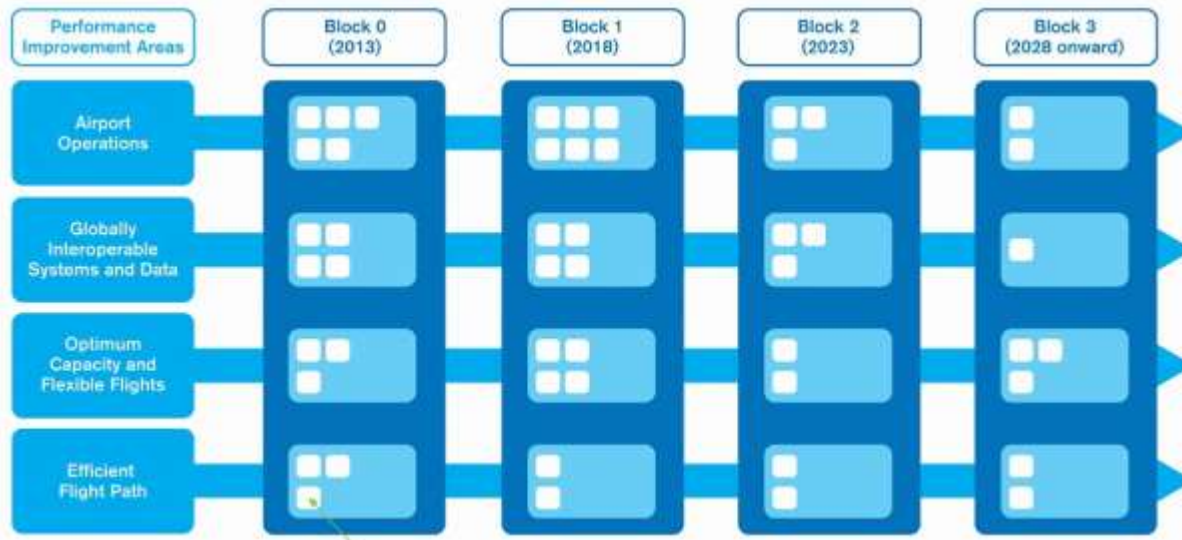
● Strict time based operation as train diagram

● A set up to share operation information with all the parties concerned

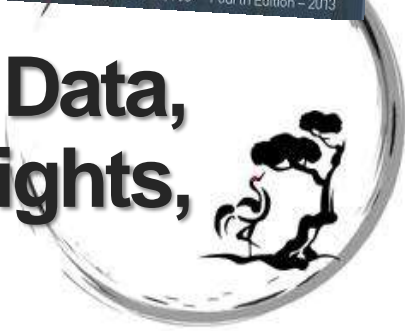


➤ ICAO “Global Air Navigation Plan” and “ASBU”

ICAO ASBU*



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



3. Major R & D Activities in ENRI

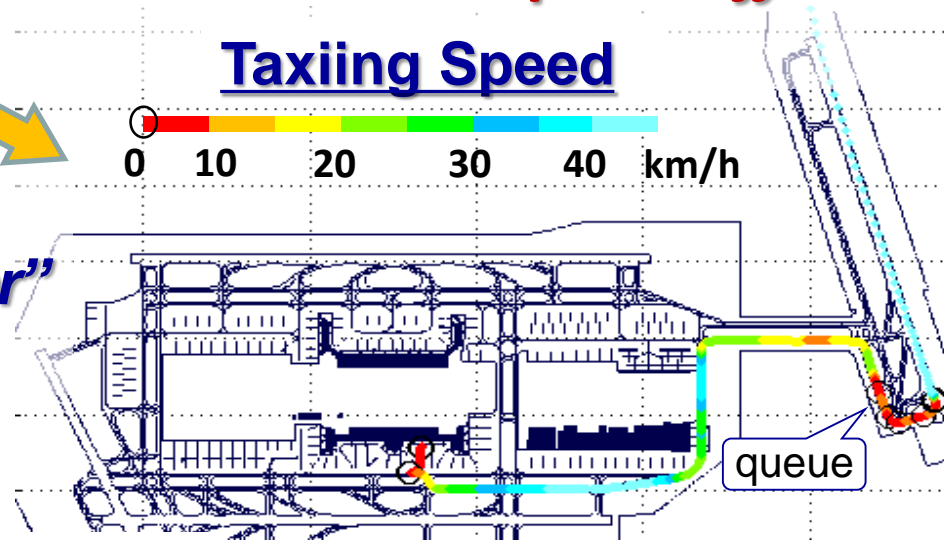
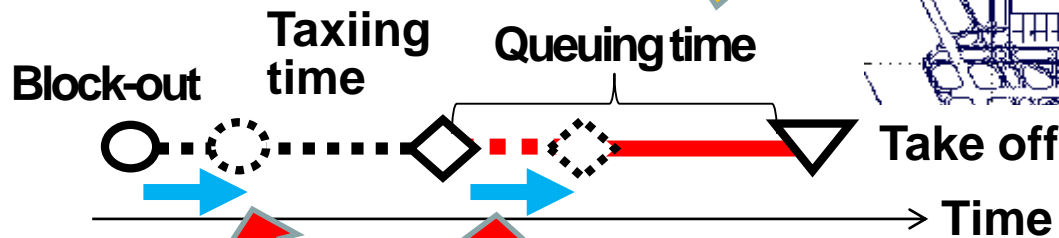


(1) Efficient Ground traffic

◆ 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



Success!

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



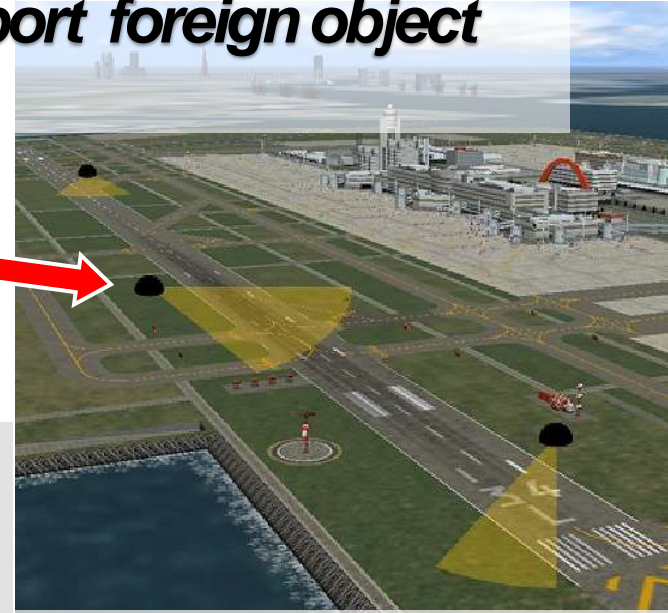
Debris

CFRP
Parabolic
Reflector

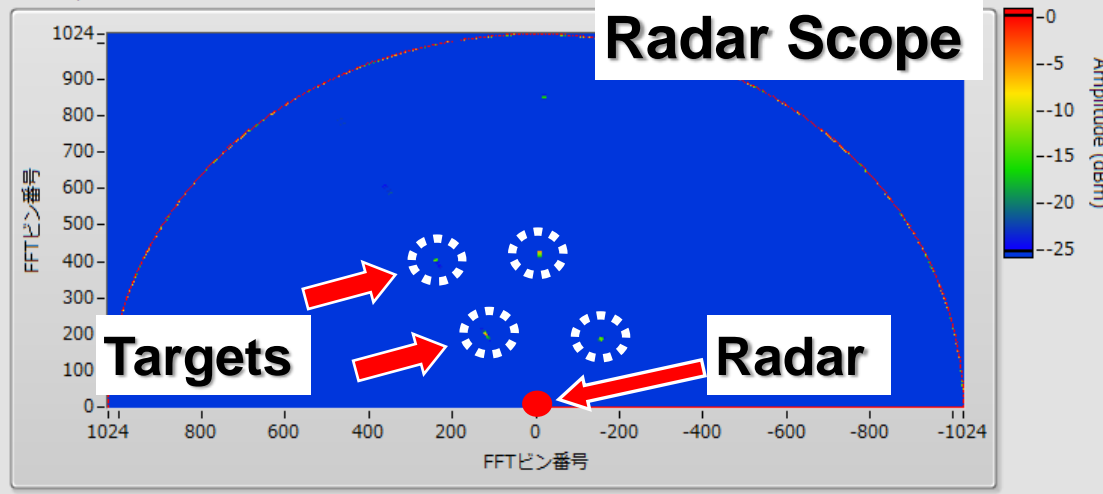
Radar
Antenna



Radiator



PPI Scope



Radar Scope

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

Boundary Coordination

gulf:	flight id:	airline:	departure:	arrival:	altitude:	bearing:
jp:ca:20140916T180000.ana888b	ANA888E	ANA	FLAA	KLAX	39000.0	72.63162994364798
jp:ca:20140916T180000.ana888d						1.70956709716797
jp:ca:20140916T180000.ana888c						1.18596809483125

Flight hand off



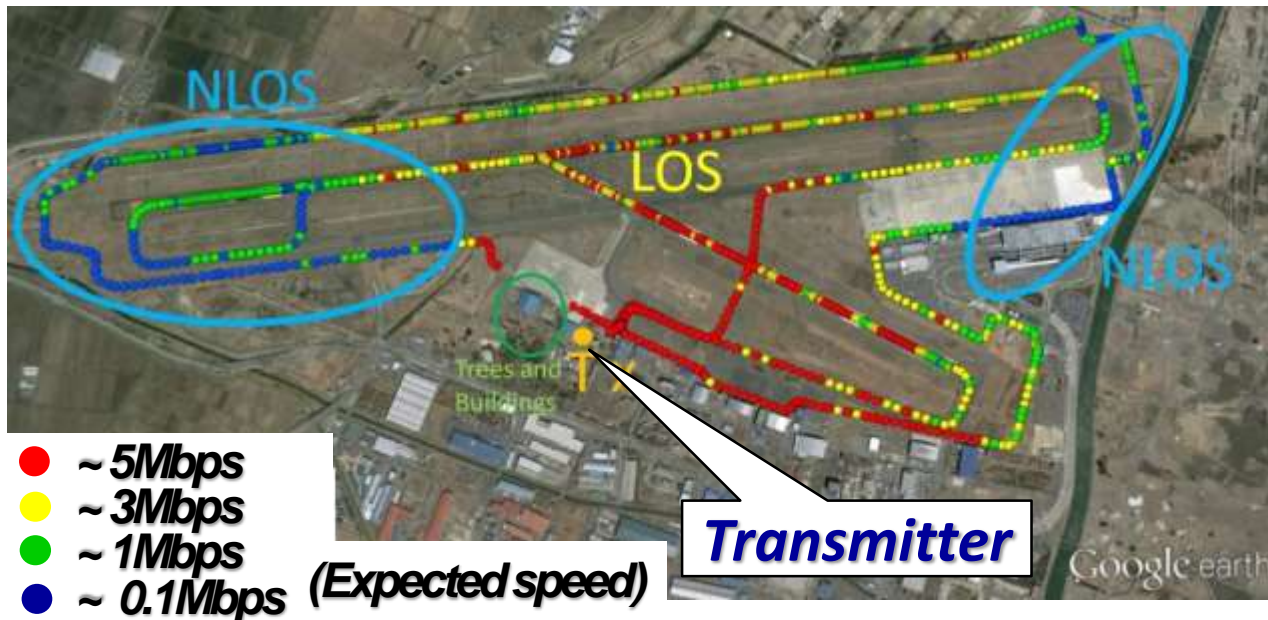
Demonstration has been a great success!

(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!

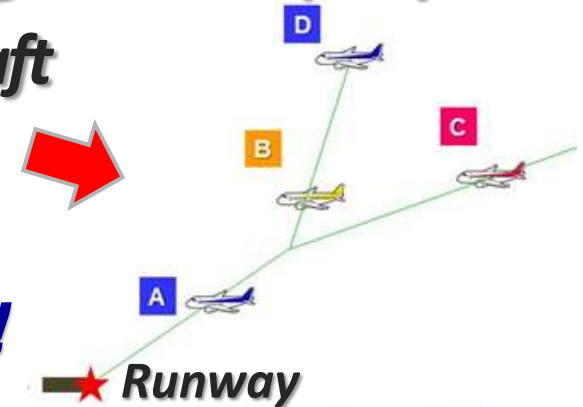
(6) Optimum **Capacity** and **Flexible Flights**

◆ **Application of Interval Management (IM)**

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

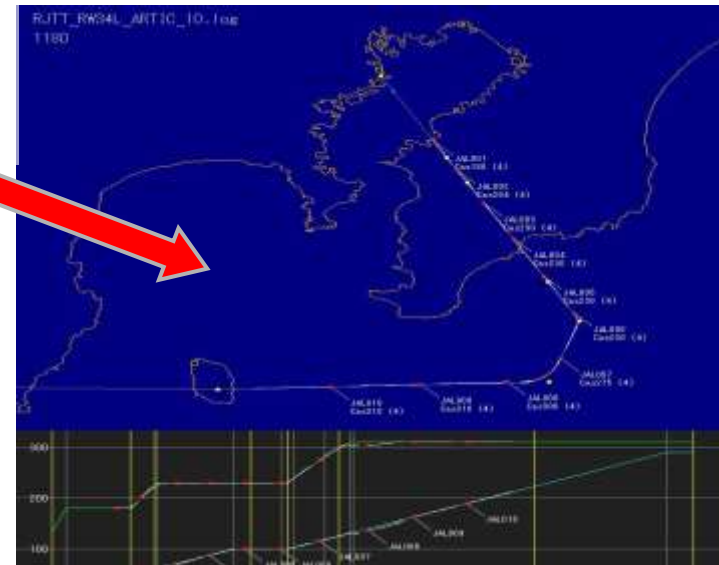


ATCO takes that role now!



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

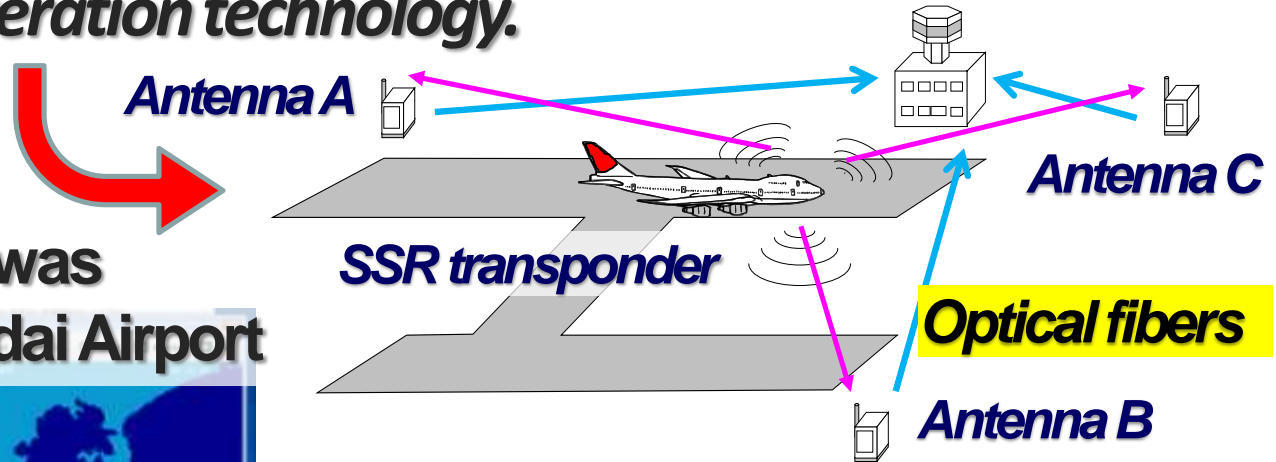
Feasibility of ASAS and normal flight merging has been demonstrated

(7) Optical fiber based *surveillance*

◆ *Development & test of OCTPASS**

**Optically Connected Passive Surveillance System*

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!

