

[EN-P4] Update of the ENRI Long Term R & D Vision (EIWAC 2010)

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Abstract: This paper describes the update of the long term research and development vision that ENRI published in 2008. The background of making the long term vision is described first. Then, the features and effects of the present vision are presented. Update of the present vision started in 2009 because of the change of social demands, new knowledge and technologies recently obtained and developed. Updated research roadmap and its features are described. The updated version has exhibited refined and easy feature as a roadmap. In addition to that, this roadmap has the prospect of promoting the continuity of research to increase our “Research power” in future competitive environment.

Keywords: ATM/CNS, Long term Research Vision, Research Roadmap

1. INTRODUCTION

Electronic Navigation Research Institute (ENRI) is a national laboratory conducting ATM/CNS research and development for more than forty years. Recently, we face increasing demand for contributing to improving present ATM system so that it can facilitate capacity expansion in air and airports, safety enhancement and smooth, efficient and on time operation. In order to respond to above demand, we made a long term research vision in 2008[1]. In the vision, we placed emphasis on realizing trajectory based operation. We made efforts to share the vision among not only researchers in ENRI but all the people working with ENRI. The vision helps ENRI researchers have the prospects for necessary future researches. The vision has been employed to develop different long term research, development and installation plans by the organizations relating to aeronautical, CNS and ATM.

This long term vision should be periodically updated because social and administrative demand in the world will change and we have to take into account newly obtained, developed and/or introduced knowledge and technologies in the future R&D planning. Therefore, we started update work of the present research vision in 2009.

In this paper, features of present ENRI long term vision will be presented first. Then, activities to identify the vision and effects of the vision will be described. Recent major changes in social and administrative demand are investigated. New knowledge or technologies are also investigated that we recently obtained or developed through the research. Problems specific in Japanese air

traffic system are described. Taking into account above changes and knowledge, future research topics are presented. Finally, updated long-term research roadmap and its features are exhibited.

2. PRESENT LONG-TERM RESEARCH VISION

2.1 Features of the present vision

ENRI published “ENRI Long-term Vision” in July 2008. In the vision, five major research domains are presented as Figure 1. Where, research domain (1) is to analyze air traffic to find and mitigate bottlenecks in the traffic. Domain (2) is to make a flight area where flexible flight paths can be set and to develop a trajectory model for precise trajectory prediction. Domain (3) aims at establishing information and communication infrastructure for data sharing. Domain (4) is surveillance and display

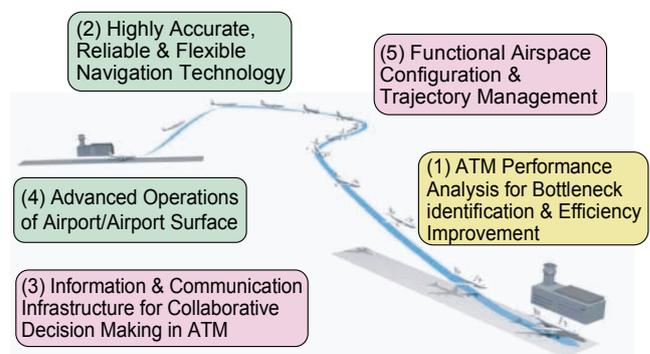


Figure 1 Major research domains in the research vision

technologies to enable smooth traffic on airport surface. Domain (5) is fundamental navigation technologies to realize precise and flexible flight near airport as “high category GBAS.” All research topics conducted in ENRI were classified into above five domains by the contents and objectives. From this classification, a research roadmap in 2009 - 2020 was made for the research vision.

2.2 Publicity and share of the vision

In order to conduct necessary researches in the vision for a new ATM system, share of research goals and cooperation to achieve the goals are essential among not only ENRI researchers but other people working together. Therefore, publicity for our research vision was done at ENRI, the Civil Aviation Bureau of Japan (JCAB) and at many academic and engineering meetings. From these activities, we believe that our research vision has been acknowledged by many people concerned.

The vision has been employed in ENRI to propose a new research plan and to evaluate it. Then, the objectives and relationship of each research topic have become recognized by many ENRI researchers.

2.3 Contribution to establishment of different future plans by aeronautical societies

JCAB established a committee to investigate future air traffic system. ENRI researchers joined the committee and provided updated information about R & D activities in the world and the research results by ENRI. They also contributed to developing JCAB’s long term vision named “CARATS: Collaborative Actions for Renovations of Air traffic Systems.”[2] Considerable amount of information in our vision has then been employed in the CARATS. In 2010, JCAB holds meetings to discuss development and installation of future air traffic systems according to the CARATS. ENRI dispatches researchers to the meeting and they are now contributing to developing the roadmap.

Our research vision has been employed in different long term visions. For example, JAXA (Japan Aerospace Exploration Agency) is now making a long term vision in aeronautical research. ENRI joins JAXA activities to construct its vision. NEDO (New Energy and Industrial Technology Development Organization) is also making a future research and development plan for Japanese aeronautical industry. ENRI joins the committee to help NEDO make more comprehensive plan by adding necessary information about aircraft operation.

3. UPDATE OF ENRI LONG TERM RESEARCH VISION.

3.1 Background of the update

Present Long term research vision describes the necessity of its update according to the change of social environment.

Since present research vision was composed through the activities of “ENRI long term research vision committee” from 2006 to 2008, the vision is based on the information obtained by 2008.

Therefore, recent social changes, newly obtained and/or developed knowledge and technologies have not been taken into account in the present vision. And, the problems specific in Japanese sky are not necessarily examined. Thus, the committee was reorganized in April 2009 and began to update the research vision. The committee is now working to complete the updated version.

3.2 Information to update the vision

3.2.1 Changes of social environment after publishing present vision

Followings are pointed out as major social changes relating to air traffic after 2008:

- a. Rapid increase in air traffic between Japan and surrounding Asian countries,
- b. Establishment of JCAB long-term vision (CARATS)
- c. Increase in international flight at Haneda Airport after its Expansion

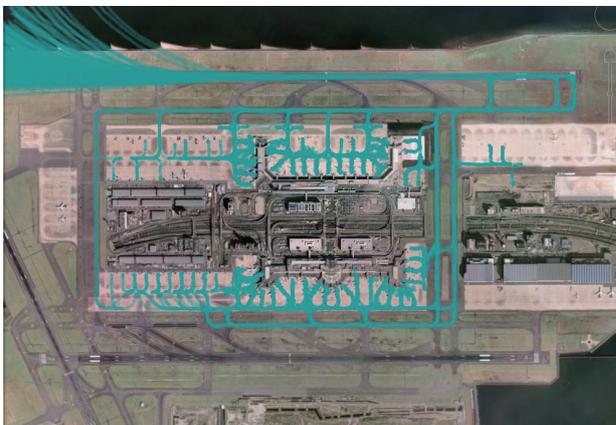
3.2.2 Newly obtained, developed and/or introduced knowledge and technologies

- a. Taxiing data from Multi-lateration (MLAT)

MLAT system is now introduced in several major Japanese airports[3]. We are now gathering MLAT data including aircraft traffic on the Tokyo Haneda Airport and analyzing them. Figure 2 shows an example of departure traffic. By the analysis, bottlenecks on the surface can be located and prediction of future surface traffic can be realized. Thus, we expect that this analysis is just a starting point for an advanced research to relieve congestion on the surface.

- b. Development of SSR Mode-S systems with Downlink Aircraft Parameters (DAPs) function

ENRI is now operating two experimental Mode-S radars



traffic can be realized. Thus, we expect that this analysis

with DAPs function[4]. By employing the DAPs function, aircraft parameters as “selected altitude” set and stored in aircraft FMS can be obtained on the ground. Thus, more precise flight trajectory can be predicted on the ground and it may be shared by all the parties concerned. Therefore, we can expect that introduction of DAPs function and analysis of aircraft parameters can lead to advanced research for trajectory based operation.

c. Electromagnetic environment in L band

Fast ground to air data link, sophisticated surveillance, and high integrity satellite navigation will be introduced in future air traffic environment. And, higher traffic density is also expected. Under such circumstances, density of electromagnetic waves in L band reserved for air navigation becomes higher, which can cause electromagnetic interference and may deteriorate the performance of new CNS systems. ENRI developed a fast and precision radio receiver to measure electromagnetic environment in the L band[5]. The receiver can exhibit current and future electromagnetic environment easily. Thus, we can expect that the data of the environment promote the research about interference tolerant CNS systems.

d. The effect of ionosphere

It is well known that electromagnetic waves from GNSS can be delayed by the ionosphere and may cause anomaly in GNSS operation. As the effect of ionosphere tends to be serious at lower latitudes, we are now collaborating with ionosphere observation facilities in Southeast Asia to accumulate and analyze data about ionosphere distribution[6]. Thus, we can expect that the research about GNSS system and its application in wider areas will be advanced.

3.2.3 Problems specific in Japanese sky

a. Traffic concentration on the metropolitan area

Figure 3 shows the number of passengers from 1978 to 2008 in domestic flight[7]. The share of passengers arrived at or departed from Haneda airport is increasing. And almost two third of total passengers uses Haneda flight in

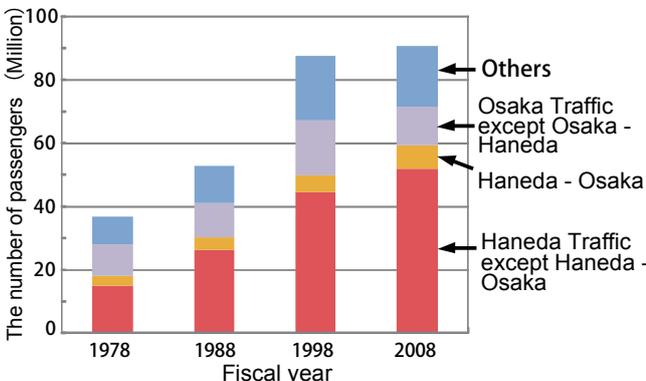


Figure 3 The number of passengers in domestic flight

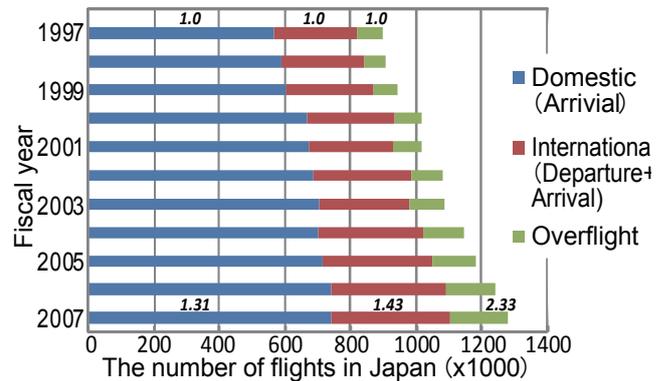


Figure 4 The number of domestic, international and over flight and its increasing rate

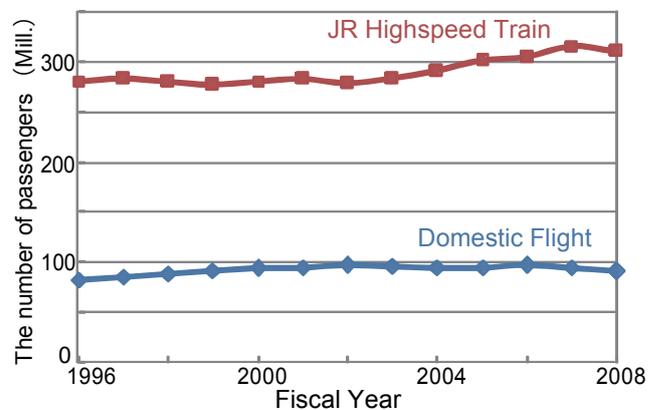


Figure 5 The number of passengers by domestic flight and high speed train

2008. Therefore, we can say that domestic flights are concentrating especially on Haneda airport.

b. Rapid increase in over flight

Figure 4 is the number of domestic, international and over flight and its increasing rate from 1997 to 2007[7]. It shows that the highest increasing rate is over flight and the lowest is domestic flight. However, the number domestic flights is still increasing because operators are downsizing their fleets. Thus, this rapid increase in over flight must be taken into account in future ATM system.

c. Competition with high speed train

Figure 5 shows the number of passengers by domestic flight and JR high speed train[8]. High speed trains carry about three times more passengers than domestic flights. And recent passenger increasing rate of high speed train is also higher. Research is then necessary to make flights more convenient and reliable under such severe competitive environment.

3.3 Short, Mid and Long-term research objectives

Present research vision defines the final research target as

“realization of smooth, efficient and on time operation.” Recently however, followings are globally emphasized to respond to rather short and mid-term problems according to social demands[9]:

- a. Enhancement of practical research and development to realize mid-term objectives,
- b. Introduction of present technologies into future operation and its performance evaluation.

When we note not only above global tendencies but our new knowledge, technologies and the specific problems in Japan, following topics must also be taken into account in the update process as mid-term problems:

- a. Congestion relief and capacity increase in metropolitan terminal areas and airport surfaces,
- b. Harmonized and smooth operation among domestic flights, international flights departing from and arriving at Japanese airports and over flights,
- c. On time operation under enhanced capacity environment,
- d. Expansion of GNSS operation, and
- e. Potential performance and the limit of present technologies to enhance present ATM.

Above research topics will then be included in the roadmap. And following objectives have been posed as

Short, Mid and Long term research in ENRI:

- a. Short-term: Wide spread, precise analysis and estimation of present en-route, terminal and surface traffic characteristics, Necessary evaluations of practical navigation systems as GBAS,
- b. Mid-term: Proposal of methods to respond to above demands and its theoretical test,
- c. Long-term: Development and evaluation of software/hardware technologies that can realize the idea proposed in the Mid-term and assistance of their introduction.

4. UPDATED LONG TERM RESEARCH ROADMAP

Figure 6 shows the updated version of ENRI’s long term research roadmap from 2010 to 2022. In the process of updating, we reviewed present research topics in ENRI and their compatibility with the present roadmap. Then, we revised the present roadmap by introducing the new knowledge and technologies described in the last section. Followings are also taken into account to make the roadmap refined and easier:

- a. Reduction of research subjects by integrating similar research topics,

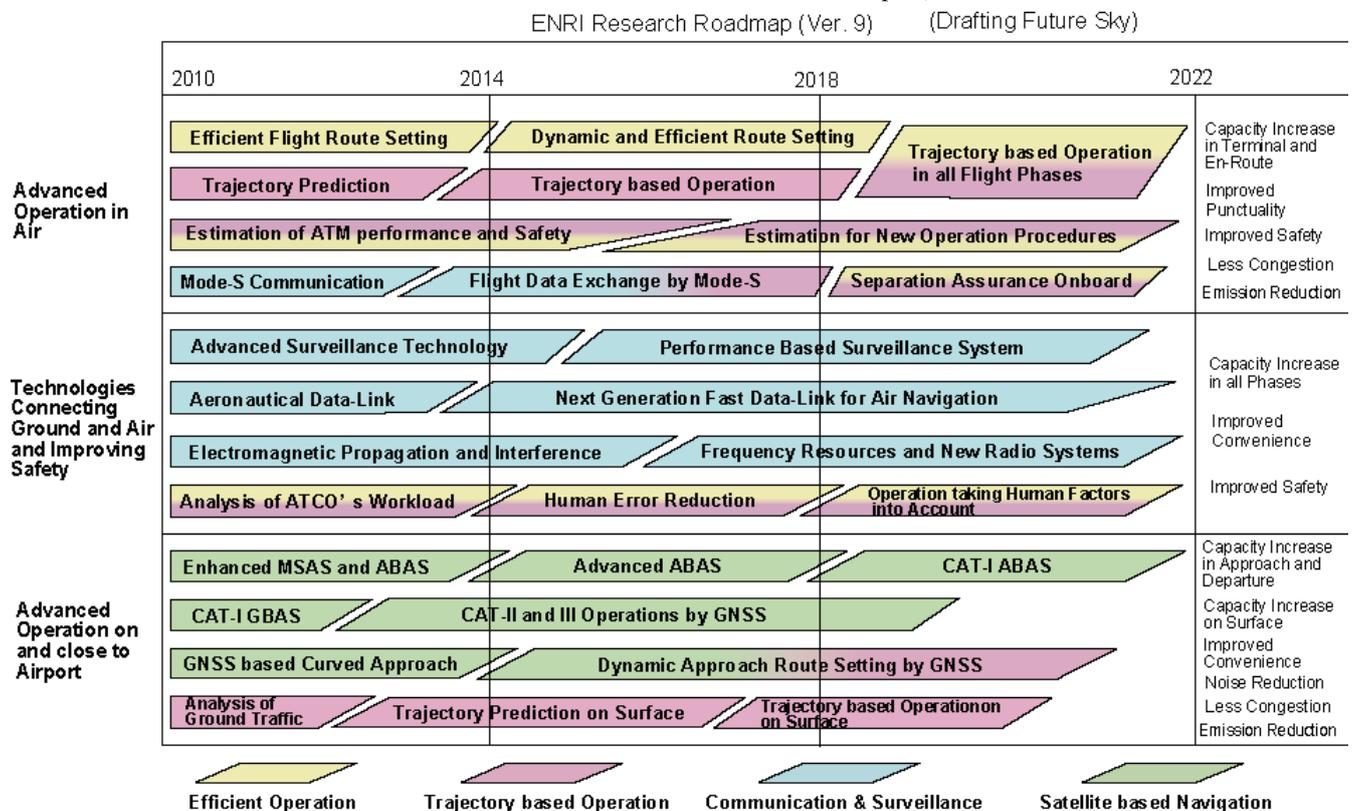


Figure 6 ENRI Research Roadmap (Revised Version), (Drafting Future Sky)

- b. Reduction of the research domains by reviewing the present subject classification so that flight phases and future key technologies will be the basis of new research domains,
- c. Consideration of mutual relationships among different subjects in the roadmap and,
- d. Consideration of research continuity by defining short, mid and long-term research results and objectives for each subject.

For example, present roadmap consists of five major research domains and sixteen research subjects in 2008. In the updated version, we set three major research domains as “Advanced operation in Air”, “Advanced operation on and close to Airport” and “Technologies connecting Ground and Air and improving Safety.” The number of research subjects has been limited to 12.

In the new research vision, the effects expected by each research subject have also been added in the end of the table. Then, each subject has been classified into four colors representing “Efficient operation”, “Trajectory based operation”, “Communication & Surveillance” and “Satellite based navigation” so that purpose or content of each research can be easily recognized.

Figure 7 shows the short and mid-term research subjects in which the relationships among each subject are shown in dotted lines and the subjects that new knowledge or technologies we introduced in the update are shown as circled numbers 1-5. Many short-term subjects are designed to conduct necessary analysis and estimation of

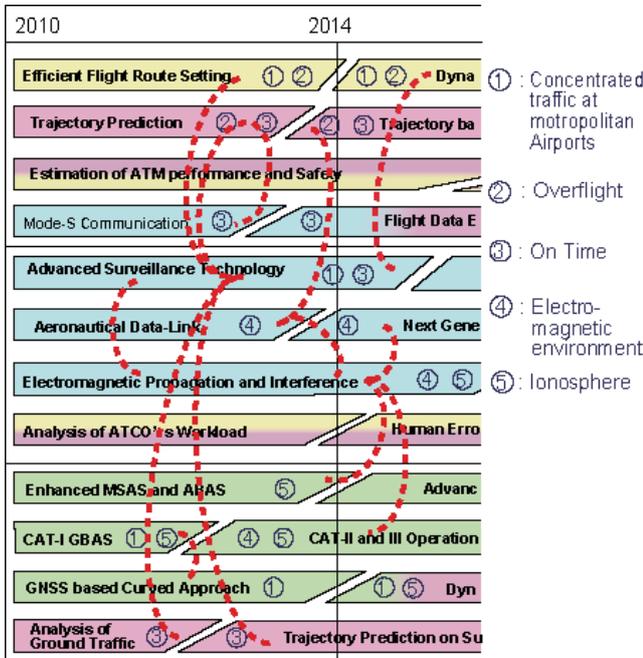


Figure 7 Relationships among each subject and the new knowledge, technologies recently introduced

en-route, terminal and surface traffic characteristics as described in **section 3.2**.

From the figure, we can easily find that most research subjects are related with each other and the results will be a source of following subjects.

5. CONCLUSIONS

ENRI published a long term research vision in 2008 to share future research plans by all the people concerned. ENRI is now updating the vision to take into account recent changes of social environment. The knowledge and technologies that ENRI recently obtained and/or developed and specific problems in Japanese sky have also been included in the update. In the updated long term research roadmap, the number of research domains and research subjects has been reduced so that refined and easy roadmap can be presented. The roadmap has shown mutual relationships among different subjects and the expected results by each subject.

This updated version has the prospect of promoting the continuity of research to increase “Research power” of each researcher in future competitive environment. Thus, we believe that this research vision will help ENRI become a center of excellence in ATM/CNS research.

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