

Laying the Groundwork for the Next Generation of Air Traffic Control

SHOTA Takeshi, YOSHIDA Hiroaki

Abstract

NEC has been developing and delivering advanced air traffic control systems that support the civil aviation bureau and air carriers in Japan for more than half a century. In the future, as the nations of the world draw ever closer together, the volume of air traffic will grow substantially, bringing with it a demand for more sophisticated and flexible air traffic control systems. This paper discusses some of the issues the aviation industry is facing going forward and explains how NEC's commitment to focusing on the next generation of air traffic control will help to solve those issues.

Keywords



air traffic control system, hybrid air-route surveillance sensor processing equipment, air traffic management system, high-speed transaction, sensing

1. Introduction

NEC has been developing and delivering air traffic control systems to Japan Civil Aviation Bureau for more than half a century. Air traffic control systems have developed in sync with the construction and expansion of hub airports and the increase in air traffic triggered by economic development in Asia. Looking to the future, the volume of air traffic is expected to continue to increase due to the emergence of various air mobility operations. Already new issues have arisen as the air traffic operating environment becomes ever more complex

as air traffic becomes more diverse. To help air traffic control systems advance into the future, it is essential that these issues be solved. In this paper, we look at NEC's efforts to date in this area, as well as its plans for the future.

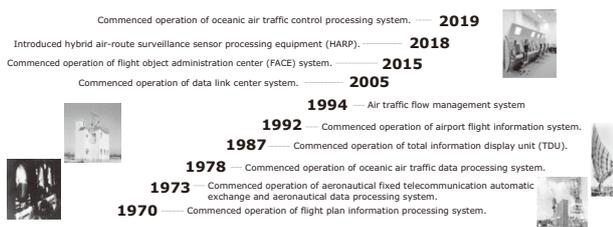


Fig. 1 Development and introduction of air traffic control systems.

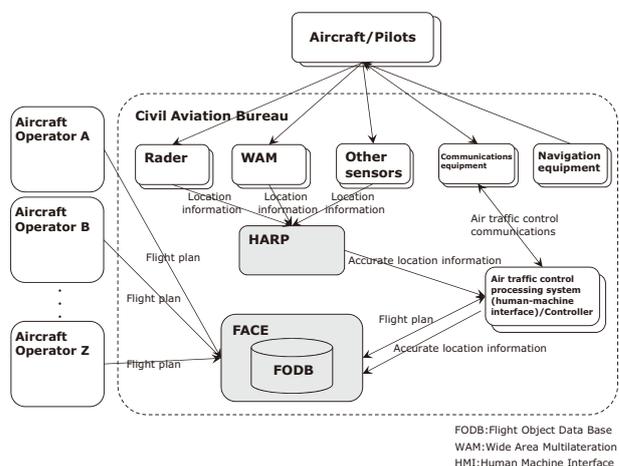


Fig. 2 Image of data linkage between FACE and HARP.

2. NEC's Air Traffic Control Systems – The Story So Far

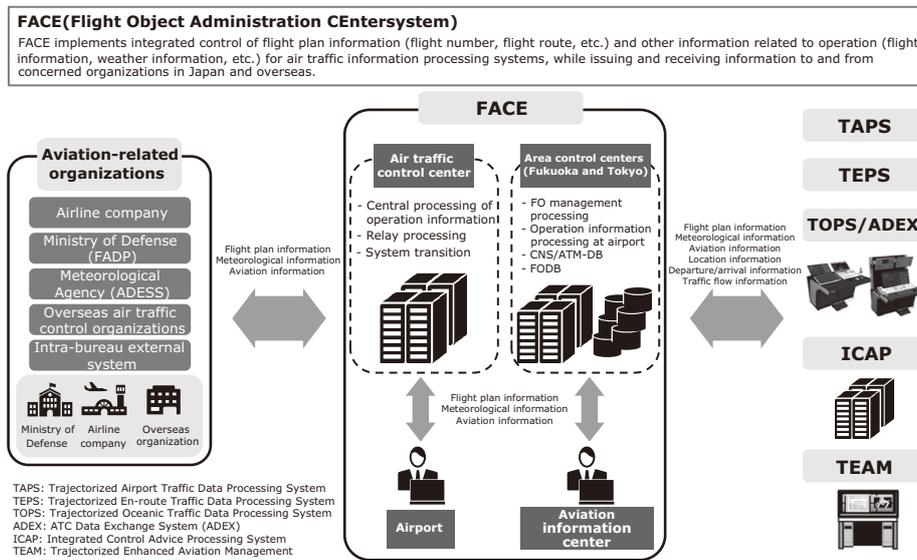
2.1 A history of development and innovation

As globalization forges tighter links between nations and economies, the role of airport and air travel has become ever more important. For more than half a century, NEC has been developing systems for air traffic

management operations in general, including air traffic control systems (Fig. 1).

2.2 Systems now in operation

Examples of large-scale systems supported by NEC include the flight object administration center (FACE) system which began operations in 2015 and the hybrid



Source: Japan Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Fig. 3 Overview of FACE¹⁾.

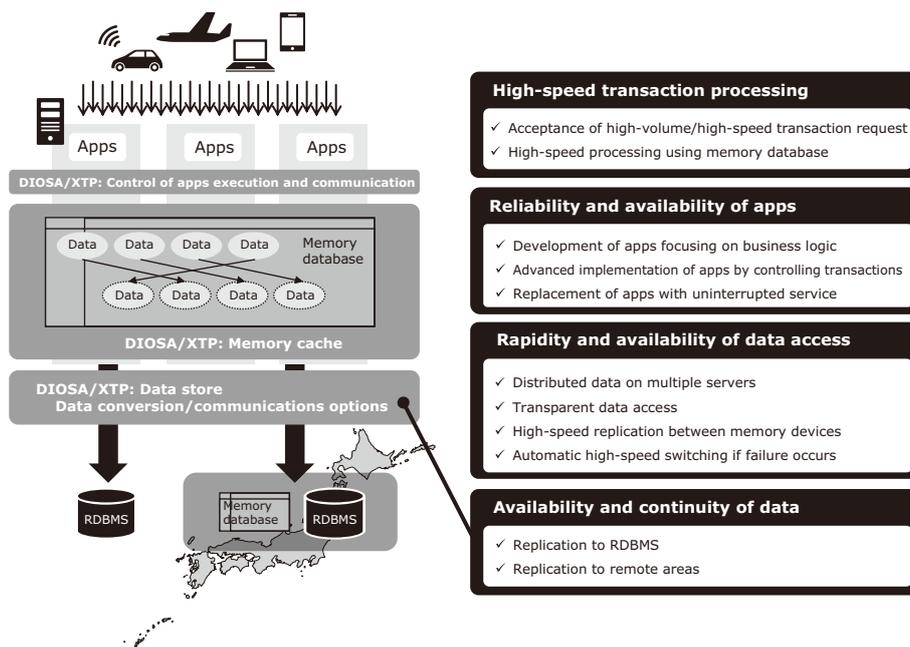


Fig. 4 Configurational concept and features of DIOSA/XTP²⁾.

air-route surveillance sensor processing (HARP) system which began operations in 2018. These are discussed in detail below.

One of the primary responsibilities of air traffic controllers is to ensure that pilots maintain sufficient space between airplanes to avoid accidents. To do this, controllers need access to the flight plans of all the aircraft in their zone, as well as real time location data (Fig. 2). In Japan, FACE plays a key role in digitization and data sharing, while HARP provides pivotal information on the operation status of the various flights. Both systems are critical to the digital transformation (DX) of air traffic control systems.

2.2.1 FACE – supporting DX of air traffic management infrastructure

Air traffic controllers manage air traffic using flight plans submitted by operators such as airline companies before flights. Flight plans include aviation call signs, departure airports, scheduled time of departure, destination airports, flight duration, cruising altitude, and other information. To help achieve more sophisticated air traffic control, we are developing a system that allows such information to be used as more detailed flight object data (to trigger DX). FACE serves as a mission-critical component of this advanced traffic control system (Fig. 3) which is transitioning from conventional operation with humans (controllers) handling each element of flight plans individually to one in which integrated flight object data managed by FACE supports supervision and decision making of controllers, thereby helping to achieve safer, more efficient air traffic control.

The system requirements for FACE are as follows.

- (1) High availability: 24-hour non-stop operation

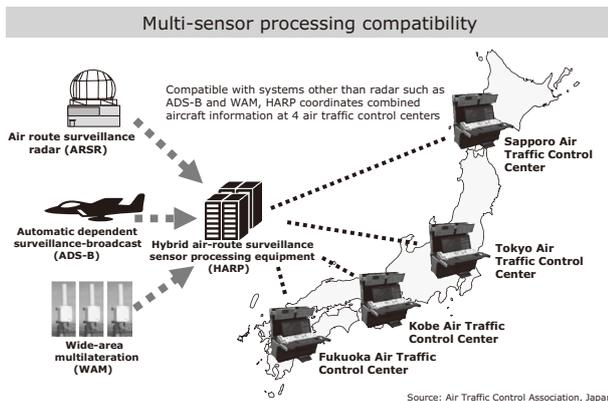


Fig. 5 Outline of multi-sensor processing compatibility of HARP³⁾.

- (2) Processing performance: Delay-free data processing for all target airplanes of air traffic control and linkage with related systems
- (3) Processing capacity: Management of data for all target airplanes of air traffic control

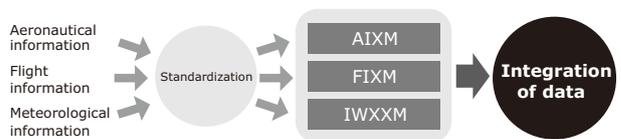
NEC technology supports the two of the three requirements FACE requires – high availability and processing performance.

FACE utilizes NEC’s DIOSA/XTP, which is a high-reliability, high-availability, large-volume high speed transaction processing platform that supports next-generation social infrastructure. DIOSA/XTP is a proprietary NEC software product that supports the construction of a large-scale, highly expandable, high-reliability, and high-availability system. The DIOSA/XTP platform achieves large-volume, high-speed transaction processing thanks to high-speed data access supported by improved reliability and availability with built-in fail-safes that can be activated in the event of system failure.

Configuration concept and features of DIOSA/XTP are shown in Fig. 4.

2.2.2 HARP effectively exploits sensor data

To achieve air traffic management that is both safer and more efficient, accurate aircraft location data must be collected in real time and delivered to air traffic controllers and air traffic control systems. Location data can be obtained using radars, as well as sensor technology such as the wide-area multilateration (WAM) sensor, which detects signals from aircraft at multiple receiving stations



Source: Council to Promote Future Air Traffic Control Systems

Fig. 6 The evolution of essential information for aircraft operation⁴⁾.

Evolution of aviation communications and data sharing systems

First generation: Teletype communications

- Aeronautical Fixed Telecommunication Network (AFTN)
- Common ICAO Data Interchange Network (CIDIN)
- Called Common Aeronautical Data Interchange Network (CADIN) in Japan

Second generation: E-mail (X.400, X.500)

- Air Traffic Services [ATS] Message Handling Services (AMHS)
- Increasing capacity of exchanged messages, forwarding binary files (XML), enhancing security, etc.

Third generation: Web service/SOA

- SWIM (System Wide Information Management)

Fig. 7 Evolution of aviation communications and data sharing systems.

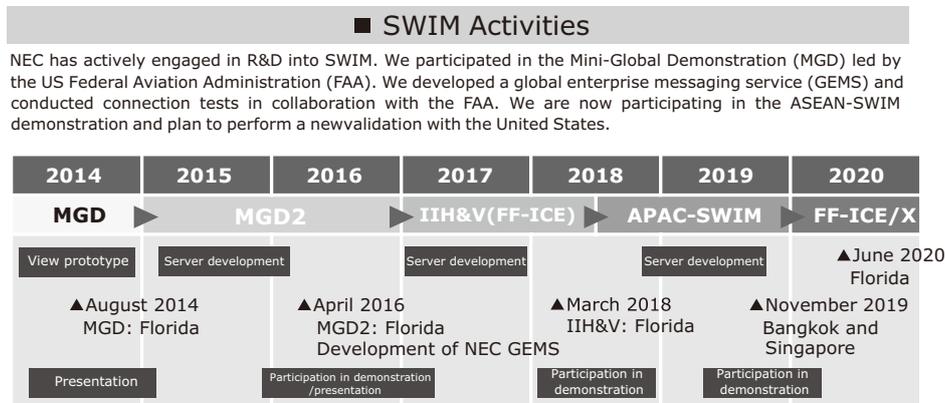


Fig. 8 NEC's commitment to international validation of SWIM.

to position the aircraft, and the automatic dependent surveillance-broadcast (ADS-B) sensor, which automatically broadcasts aircraft location information (Fig. 5). By taking advantage of the high reliability of radar together with the high precision and high frequency of WAM and ADS-B, HARP is able to obtain extremely precise aircraft location information derived from multiple sensors and provide it to air traffic controllers in real time.

3. Supporting DX in Air Traffic Management

3.1 Digitization in the air traffic management sector

The air traffic management sector is now undergoing a period of transition to increased data sophistication (from text format to XML/GML format). For example, it is planned that a new data conversion model called a flight information exchange model (FIXM) will be introduced to convert text-format flight plans to XML-format flight object information (Fig. 6).

Similarly, international standardization is underway as evidenced by the fact that weather information will be standardized in the ICAO Meteorological Information Exchange Model (IWXXM) and aircraft safety related information will be standardized in the Aeronautical Information Exchange Model (AIXM). Various efforts for social implementation of these standards are also underway.

To handle the increasingly complex data being produced, aviation communications and information sharing systems have been updated as shown in Fig. 7.

These shifts reflect international trends towards universal standards as epitomized by the System-Wide Information Management (SWIM) system whose proponents are hoping to achieve a global-scale "system of systems." These efforts are essential in the air traffic management sector. In today's interconnected world, it

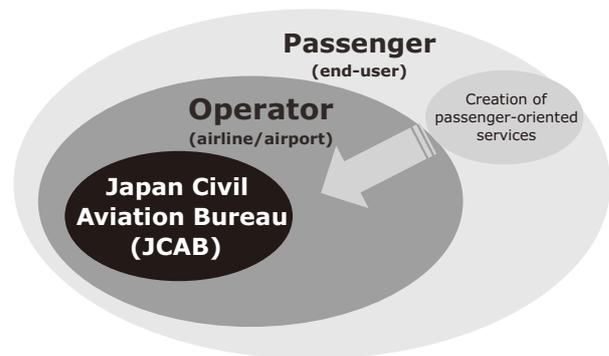


Fig. 9 Passenger-oriented DX in air traffic management.

would be counterproductive for individual countries to develop independent air traffic management systems of their own when a necessary assumption is that many flights will be on international routes (Fig. 8).

With an eye towards integrated management of air traffic data — including the FACE system, NEC has taken the initiative in developing systems to handle high volumes of complex data and is now reviewing social implementation of SWIM. We are now actively participating in international validation projects in the Asia-Pacific region and acting as the driving force, together with the United States, in pushing forward international efforts to achieve universal standards.

3.2 Promoting DX in air traffic management

One of the most important reasons why we are committed to DX in air traffic management is to enhance the international competitiveness of Japan's airline and airport companies, while accelerating digitization of the aviation industry as a whole. To achieve this, we will also make efforts to help the airline and airport com-

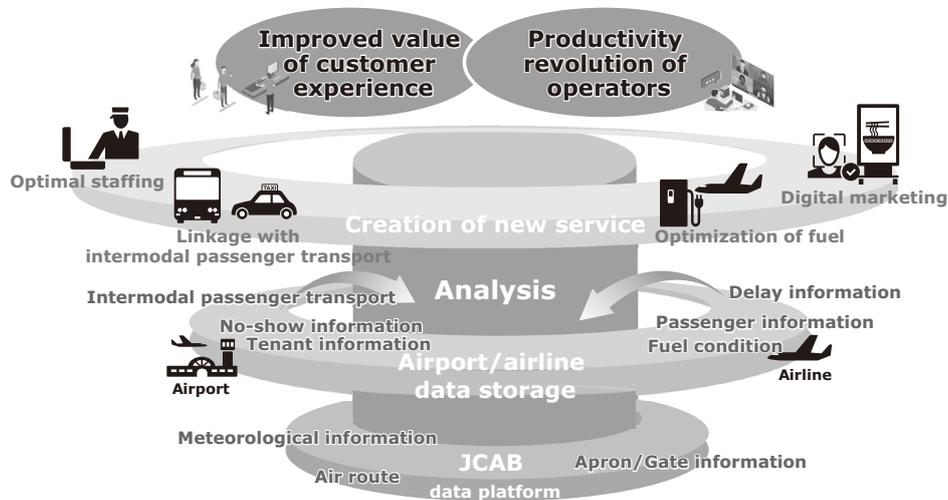


Fig. 10 How DX in air traffic management is achieved.

panies achieve utilization of data that can contribute to improved value of experience from the viewpoint of passengers. This goes beyond conventional efforts to improve the efficiency and sophistication of air traffic control operations and airport management and involves effectively utilizing data to improve the customer experience (Fig. 9).

When SWIM comes online, all operators will be connected to each other. Full utilization of SWIM data will improve the customer experience and revolutionize operator productivity. For example, by linking data from airline companies with intermodal passenger transport and communities, it will be possible to offer a wide range of services — such as seamless multimodal route search — to help travelers to enjoy pleasant, stress-free trips. This technology can also help to enhance the work experience by optimizing staffing and reforming work styles.

Building on our long history and experience in the aviation industry, NEC will continue to contribute to the progress of the Japanese aviation industry by helping them achieve DX in air traffic management (Fig. 10).

4. Conclusion

In this paper we have outlined the efforts NEC is making to support air traffic management and help transform aviation into a more robust, future-ready industry. We will continue to adapt to changes in technology and the environment as we strive to develop systems that maximize customer value and contribute to further advances in air transport.

In conclusion, we would like to express our gratitude to the MLIT Civil Aviation Bureau as well as other con-

cerned organizations and manufacturers who have been so generous in instructing and helping us develop the systems introduced in this paper.

Reference

- 1) MLIT Civil Aviation Bureau: Overview of Flight Object Administration Center (FACE) System (Japanese)
<https://www.mlit.go.jp/koku/content/001358997.pdf>
- 2) DIOSA/XTP: Large-Volume High Speed Transaction Processing Platform (Japanese)
<https://jpn.nec.com/diosaxtp/index.html>
- 3) BANNO Kimiharu: Challenges We Will Face in National Air Traffic Control and Actions to Address Them, 2016 Air Traffic Control Seminar, October 2016 (Japanese)
http://atcaj.or.jp/wordpress/wp-content/uploads/2017/01/H28_ATCAJ_Seminar_mlit.pdf
- 4) Council to Promote Future Air Traffic Control Systems Information Management Study Working Group: 2014 Activity Report, 2015 (Japanese)
<https://www.mlit.go.jp/common/001088139.pdf>

Authors' Profiles

SHOTA Takeshi

Senior Manager
Radio Application, Guidance and Electro-Optics Division

YOSHIDA Hiroaki

Manager
Radio Application, Guidance and Electro-Optics Division

Information about the NEC Technical Journal

Thank you for reading the paper.

If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Japanese

English

Vol.16 No.1 Social Infrastructure that Guarantees Safety, Security, Fairness, and Efficiency

Remarks for the Special Issue on Social Infrastructure that Guarantees Safety, Security, Fairness, and Efficiency
Building a World Where Everyone Can Enjoy Abundance and Well-being through Innovative Social Infrastructure Technologies

Papers for Special Issue

Technologies for Achieving Digital Transformation (DX) of Social Systems: DX of Government and Administrative Services

The Future of Cloud in Promoting Digital Government
Supporting the Commitment of Local Governments to Digital Transformation (DX)
Collaborative Learning Support Solution Based on Speech Visualization

Technologies for Achieving Digital Transformation (DX) of Social Systems: DX of Broadcasting Systems

Providing Video Platform Service as New Social Infrastructure to Facilitate Digital Transformation (DX) of Video Distribution
New Video Coding Technology Provides the Foundation for the Forthcoming Digital Transformation (DX) of the Broadcasting Industry

Technologies for Achieving Digital Transformation (DX) of Social Systems: DX of Airports

Electronic Customs Declaration Gates to Reduce Congestion at Airport Customs Inspection Areas
Introducing Face Express, a New Boarding Procedure Using Face Recognition (One ID at Narita Airport)
Development of a GPS-based Aircraft Approach and Landing System (GBAS: Ground Based Augmentation System)
Laying the Groundwork for the Next Generation of Air Traffic Control

Sensing Technologies Underlying Social Systems: Sensing Technologies That Work Behind the Scenes

Optical Sensor Technology Supporting the Climate "SHIKISAI" (GCOM-C) Satellite and Its Achievements
Monitoring Infrastructure with Synthetic Aperture Radar (SAR) Satellite Service for Safe and Secure Society
Observation of Internal Structures Using Muography
Manipulating the Underwater Propagation Path of Sound Waves with Variable Depth Sonar
Development of Mid-Mast TACAN Radio Beacon Antennas for Ships
Onboard Track Patrol Support System — Supporting Railway Track Inspection with Advanced Image Analysis

Sensing Technologies Underlying Social Systems: Sensing Technologies for Detection and Recognition

NEC's Radio Identification Technology: Current Status and its Future
The Current Status and Future Prospects of Deep Learning-Based Fingerprint Matching Technology
Measurement of three-dimensional information of the face and its application to facial image examination
Invisible Sensing – Walk-through Security Screening

Cutting-edge Technologies to Build a Better Future: Advanced Technologies Permeate Every Facet of Our Lives

Development and Approach to Software-defined Radio Technology
Automation and Labor-Saving Technology for Satellite Operation
Quantum Cryptography — the Next Generation of Light-based Cryptographic Technology
Labor-saving and Unmanned Robotics Takes the Effort out of Physically Demanding Work
Development of Wireless Power Transfer Antenna Capable of Efficiently Transmitting High Power to Unmanned Underwater Vehicles

Cutting-edge Technologies to Build a Better Future: Advanced Technologies in Space Applications

The Ion Engine of Hayabusa2 and Potential Applications
Hayabusa2 — Autonomous Navigation, Guidance and Control System Supported Pinpoint Touchdowns on Asteroid Ryugu
Spaceborne LIDAR-Supported Autonomous Landing of Hayabusa2 Spacecraft with Remote Sensing Technology
Hayabusa2: System Design and Operational Results
Optical Inter-satellite Communication Technology for High-Speed, Large-Capacity Data Communications
Development of 30 kW-Class X-Band Solid State Power Amplifier for the Misasa Deep Space Station
Development of the World's Highest-Performance Thin Membrane Solar Array Paddle



Vol.16 No.1

October 2021

Special Issue TOP

NEC Information

2020 C&C Prize Ceremony