Laying the Groundwork for the Next Generation of Air Traffic Control

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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.

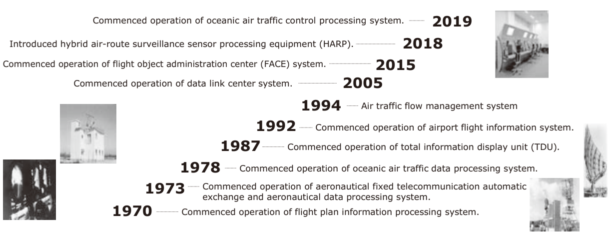


Fig. 1 Development and introduction of air traffic control systems.

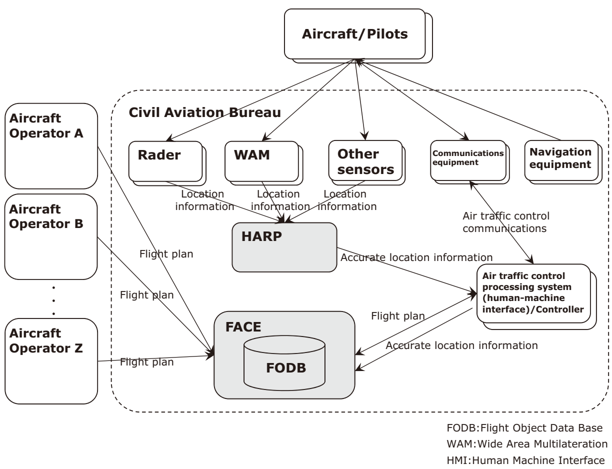


Fig. 2 Image of data linkage between FACE and HARP.

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

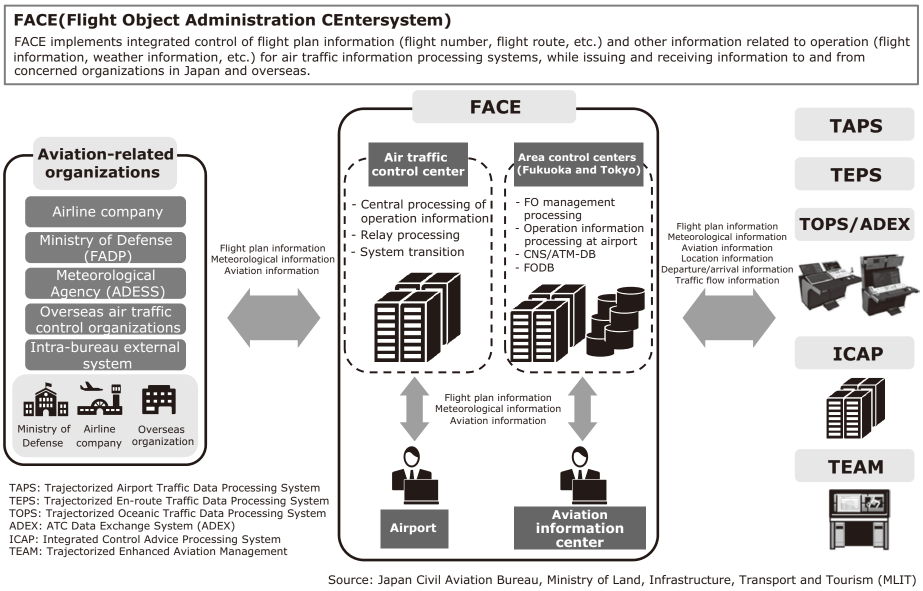


Fig. 3 Overview of FACE[1].

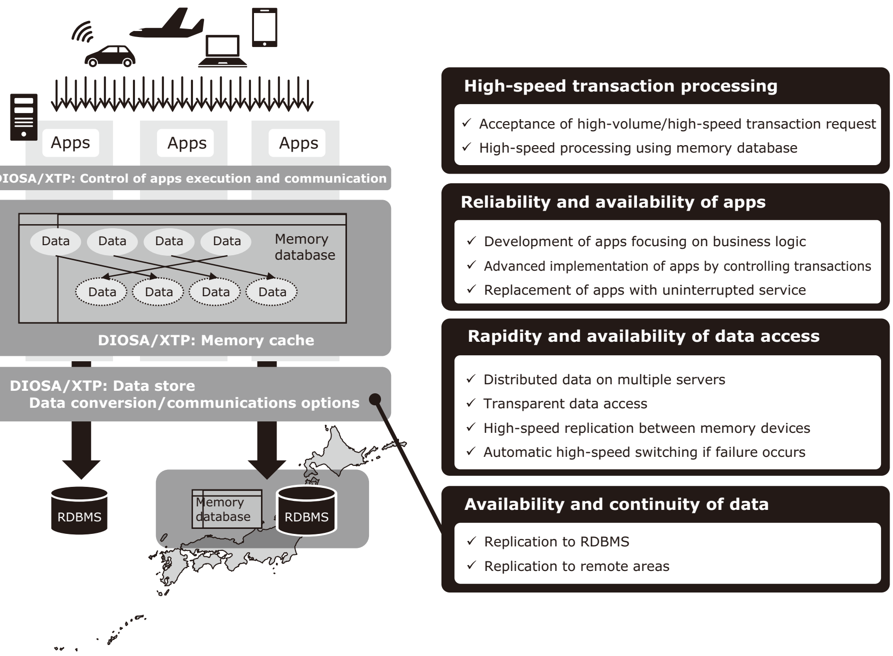


Fig. 4 Configurational concept and features of DIOSA/XTP[2].

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

(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

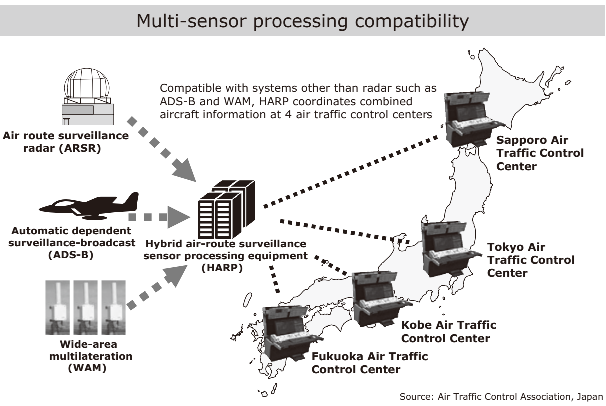
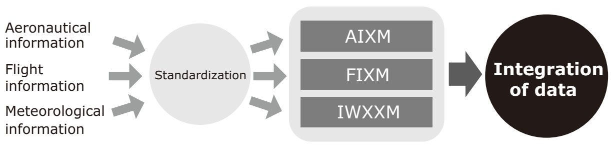


Fig. 5 Outline of multi-sensor processing compatibility of HARP[3].



Source: Council to Promote Future Air Traffic Control Systems

Fig. 6 The evolution of essential information for aircraft operation[4].

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.

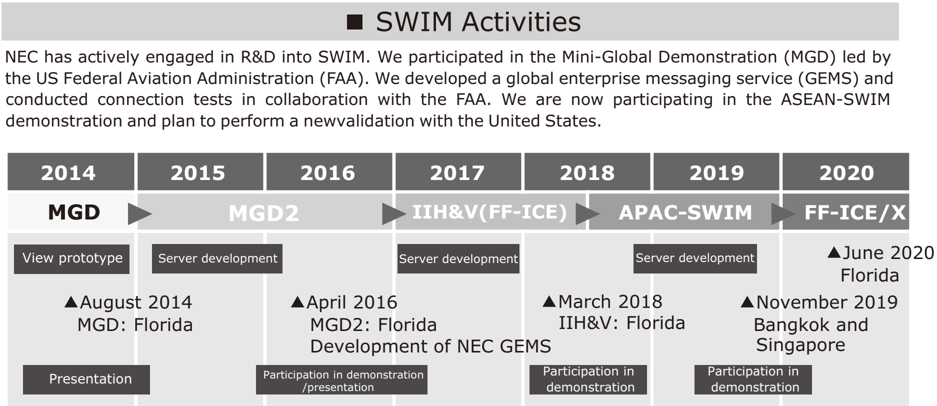


Fig. 8 NEC's commitment to international validation of SWIM.

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 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**).

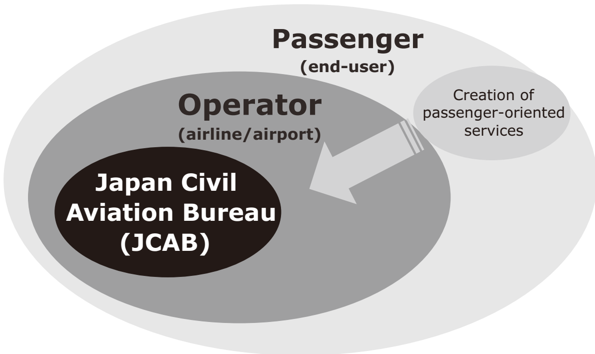


Fig. 9 Passenger-oriented DX in air traffic management.

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-

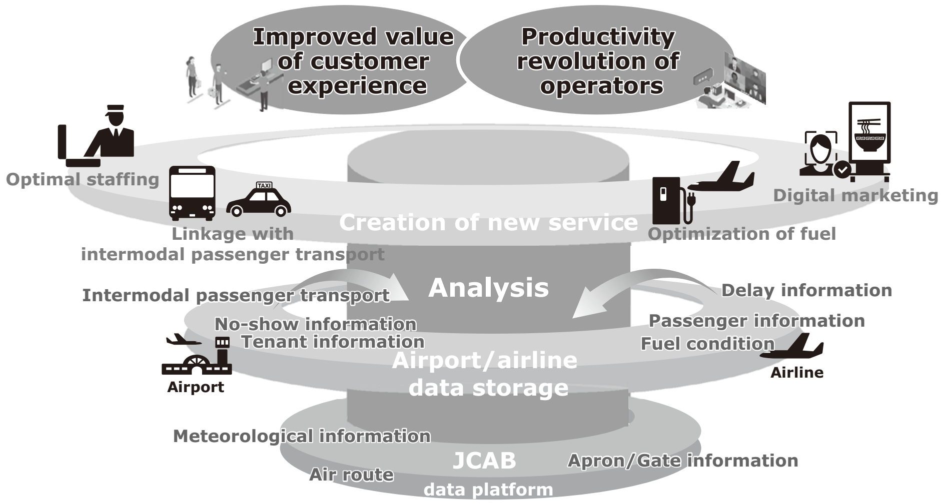


Fig. 10 How DX in air traffic management is achieved.

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

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