Introduction to the Sixth ENRI International Workshop on ATM/CNS (EIWAC2019)

S. Ozeki, Y. Fukuda, S. Fukushima, T. Koga, T. Sakai, E. Itoh, and N. K. Wickramasinghe

Abstract This chapter provides an overview of the sixth ENRI International Workshop on ATM/CNS (EIWAC2019), together with summaries of presentations in keynote sessions and special speeches. It also explains the Electronic Navigation Research Institute's approach to organizing EIWAC. EIWAC2019 was held in Nakano, Tokyo, from October 29 to 31, 2019. In the workshop, various aspects of air traffic management (ATM) and its enablers in the fields of communication, navigation, and surveillance (CNS) were discussed.

Keywords Global Air Safety Plan · Global Air Navigation Plan · ATM · CNS · UTM · Standardization

1 Introduction

The Electronic Navigation Research Institute (ENRI) is part of the National Institute of Maritime, Port, and Aviation Technology (MPAT). MPAT was established in 2016 by uniting research institutes affiliated with Japan's Ministry of Land Infrastructure, Transport, and Tourism (MLIT). ENRI has been conducting research and developing and testing electronic navigation systems for almost half a century. It is now the only institute in Japan specializing in air traffic management (ATM) and communication, navigation, and surveillance (CNS) for aviation.

Air traffic is increasing steadily all around the world. Mitigation of congestion and reduction of environmental impact while maintaining safety and efficiency have been common interests for the whole world for the last decade. Demand for increased air traffic capacity, efficiency, and safety has been particularly strong in the Asia-Pacific region because Asia has the fastest-growing rate of air traffic. ENRI is therefore conducting R&D in order to respond to this demand, and provides timely solutions through improved national, regional, and global aviation systems.

S. Ozeki · Y. Fukuda · S. Fukushima · T. Koga (✉) · T. Sakai · E. Itoh · N. K. Wickramasinghe
Electronic Navigation Research Institute (ENRI), 7-42-23, Jindaiji-Higashi-Machi, Chofu, Tokyo 182-0012, Japan
e-mail: koga@mpat.go.jp

Air Traffic Management and Systems IV, Lecture Notes in Electrical Engineering 731,
https://doi.org/10.1007/978-981-33-4669-7_1

In addition to its R&D activities, ENRI is now expected to contribute to harmonization and standardization regarding the current and emerging ATM/CNS technologies and operations, which will lead to fully harmonized global aviation systems with modern performance-based technologies and procedures. However, it is not necessarily easy for the aviation community in the Asia-Pacific region to share comprehensive information on the latest ATM/CNS technologies and operations. This is because there are different local traffic policies and ATM/CNS capabilities.

In view of this, ENRI decided to organize an international workshop to discuss ATM/CNS technologies and operations, mainly for the Asia-Pacific region, but also for the rest of the world as well. This workshop was named "ENRI International Workshop on ATM/CNS (EIWAC)." The first workshop was held in 2009. Since then, EIWAC has been held biannually, and the latest one (EIWAC2019) was held in October 2019 in Tokyo.

The purpose of publishing this book is to share selected topics presented and discussed in EIWAC2019. This chapter first gives an overview of the EIWACs, presenting the speaker, title, and a summary of each speech in the plenary session. Selected papers from the technical sessions are provided in Chaps. 2, 3, 4 and 5.

2 Overview of the EIWACs

ENRI would like to thank the members of the EIWAC Technical Program Committee (EIWAC-TPC) for their tremendous contributions to making the workshop more attractive to potential participants. Members from other organizations offered comments to help improve EIWAC by including viewpoints from outside ENRI.

EIWAC has sessions for keynote speakers, and other sessions for technical discussions on operations and R&D as well. The keynote sessions of EIWAC are held to share strategic updates among participants and are scheduled to take place on the first day in most cases. The technical sessions offer participants opportunities to review operational facts and the progress of R&D with reference to updates from the keynote sessions.

Table 1 presents a brief summary of the 1st to 3rd EIWACs, and Table 2 summarizes the 4th to 6th. The workshop started in 2009 as a two-day event and was later expanded to include one more day for technical sessions, to accommodate more presentations. It continues to grow as international participants offer more presentations and side meetings [1–6].

One of the advisors to ENRI suggested that outstanding papers for EIWAC should be made more visible to more researchers and students in the aviation community, in order to encourage the next generation. ENRI responded to this comment in 2012 by engaging an editorial team to compose the first book, "Air Traffic Management Systems," collecting selected papers from EIWAC2013 [7]. This was followed up with "Air Traffic Management Systems—II" from EIWAC2015 [8], and "Air Traffic Management Systems—III" from EIWAC2017 [9]. These books were published by Springer Japan in 2014, 2017, and 2019, respectively.

Table 1 Summary of the EIWAC series (2009, 2010, 2013)

Meeting #	1st	2nd	3rd
Name	EIWAC2009	EIWAC2010	EIWAC2013
Dates	March 5–6, 2009	November 10–12, 2010	February 19–21, 2013
Venue	Ohtemachi Sankei Plaza, Ohtemachi, Tokyo	Akihabara Convention Hall, Akihabara, Tokyo	Odaiba Miraikan Hall, Odaiba, Tokyo
Theme	Towards future ATM/CNS	Safety, efficiency and environment	Drafting future sky
Keynote speakers	4	7	9
Panel session	N/A	"Future of automation in ATM," six panelists	"Future ATM: centralized, de-centralized or best mixed," four panelists
Other sessions			Poster, tutorial
Technical sessions	6	19	17
Presentations	22, incl. 9 from Japan	45, incl. 12 from Japan	46, incl. 13 from Japan
Participants	480	550	539
On 1st day	N/A	N/A	238
Non-Japanese	20	60	80
Countries	7	14	13

3 Keynote Speeches

This section gives a summary of the keynote speeches in EIWAC2019. EIWAC2019 had seven keynote speeches on day one.

3.1 Stephen P. Creamer, "Exploring Ideas for World Aviation Challenges"

Mr. Creamer is the director of the Air Navigation Bureau (ANB) of the International Civil Aviation Organization (ICAO). His presentation was about the latest activities of the ANB and digital transformation perspectives. ICAO works toward the vision of achieving sustainable growth of the global civil aviation system. The ANB's areas of focus are two of ICAO's five strategic objectives: Aviation Safety and Capacity and Efficiency.

The 40th ICAO Assembly in 2019 endorsed the Global Aviation Safety Plan (GASP) and the Global Air Navigation Plan (GANP) updates. The vision of the GASP is to achieve and maintain the aspirational safety goal of zero fatalities in commercial operations by 2030 and maintain it thereafter. The GASP promotes the

Table 2. Summary of the EIWAC series (2015, 2017, 2019)

Meeting #	4th	5th	6th
Name	EIWAC2015	EIWAC2017	EIWAC2019
Dates	November 17–19, 2015	November 14–16, 2017	October 29–31, 2019
Venue	Ryogoku KFC hall and rooms, Ryogoku, Tokyo	Congres Square Nakano, Nakano, Tokyo	Nakano Central Park conference, Nakano, Tokyo
Theme	Global harmonization for future sky	Drafting future skies	Exploring ideas for world aviation challenges
Keynote speakers	13	5	7
Panel session	N/A	N/A	Digitalization in aviation: a standardization perspective
Other sessions	Poster	Poster, tutorial	Poster, special speech
Technical sessions	18	17	18
Presentations	70, incl. 30 from Japan	71, incl. 25 from Japan	72, incl. 19 from Japan
Participants	744	630	861
On 1st day	259	205	268
Non-Japanese	174	180	257
Countries	17	13	19

implementation of safety management and a risk-based approach. A series of six goals in the GASP support the overall aspirational safety goal. These goals call for states to implement effective safety oversight systems and state safety programs. The GANP requested ICAO to take action to evolve toward a performance-driven, strategic planning environment that interacts with regional development and implementation programs. The sixth edition of the GANP is organized into a multilayer structure. The four-layer structure facilitates decision-making by providing stable strategic direction for the evolution of the air navigation system.

Frontier technologies provide innovative solutions and tools to the air transport system, such as automation and unmanned systems, transport electrification, big data, artificial intelligence, machine learning, and digitalization of processes. New technologies incur relatively low development costs, allowing small and medium-sized "start-up" enterprises to be at the forefront of transformation in air transport. New entrants are drones that fly below 400 feet and above high altitudes, and spacecraft under autonomous control. There are challenges in the wake of these technological developments, which calls for an unprecedented design of a balanced environment capable of fostering innovation. Regulatory and policy transparency and enforcement, legal certainty for businesses, cybersecurity, consumer and data protection,

and a fair, environmentally, economically, and socially sustainable development on a global scale will be ensured.

Global traffic density is increasing. The only way to meet this demand is going to be a transformative reliance on exchange of information in the air traffic management (ATM) system. A large number of digital parts are migrating into airplanes. Everything is becoming fundamentally based on digital technology, as seen for example in the evolution of manufacturing technologies, remote towers, the way people move through airports, and the way freight moves through the system. All the parts of the aviation ecosystem are always interacting, so digital transformation is a big deal.

When you make things digital, you make them vulnerable to cyberthreats. If every state puts in place a different infrastructure or a different architecture to respond to these threats, it's going to be really hard to maintain interoperability. We need to find a way to create a system architecture that takes cybersecurity into consideration as a foundational element. The 13th Air Navigation Conference recommended that ICAO establishs a formal project for the urgent and transparent development of a globally harmonized aviation trust framework.

The first ICAO trust framework was set up in 1944 with the establishment of the Chicago Convention. ICAO establishes international standards. Those standards are used by civil aviation authorities to issue certificates. Because they're issued in relation to these standards, other authorities recognize these certificates and trust is established. It's old fashioned and it isn't digital, but it's worked well ever since it started. There are volumes of standards used to regulate licenses, certificates, authorizations, and approvals. We need to develop solutions to accommodate new entrants. Therefore, we need to talk about how to move this out of the paper world and into the digital world.

Within a trust framework, it's a foundational fact that you need to know who is in your network so you know how to secure your network. Digital certificates are extremely efficient and are used all over the world in a form referred to as a public key infrastructure (PKI) system. You could use those commercial parties' mechanisms to distribute digital certificates. All we do is put some other governance on top of it. You need a digital certificate so you can secure your organization, drone, or airplane's communications with the rest of the network. So, whenever your aircraft or air navigation service provider sends or receives a message request, the sender and receiver identify each other and integrity can be validated back with the trust bridge.

For decades, we've been trying to isolate ourselves from the rest of the world with physical isolation. This is just really hard to do now, because no matter how hard you try, your data is going to cross paths with the rest of the world. ICAO can figure out how many addresses we need and how big an address block we we'd have to get. Therefore, ICAO needs to work with the Internet's governing bodies to obtain top-level domain and private address space capacity. These assets could be made "private" and could provide a first layer of logical isolation from the public Internet.

ICAO can facilitate a globally trusted identity, but each stakeholder will have to decide how it should be used in its own system. As threats evolve, new controls will be needed to ensure trust framework entities continue to operate within their roles. ICAO is best positioned to develop a protected and globally harmonized architecture.

In conclusion, Mr. Creamer summarized four points: (1) Focus on staying safe as we introduce change; (2) the pace of change is accelerating because of new entrants; (3) the underlying connectivity challenge has to be handled first; and (4) bringing along regulators and other safety workers to stay abreast of the changes is just as important as the underlying technology.

3.2 Florian Guillermet, "The Digital Transformation of Air Traffic Management: Why and How"

Mr. Guillermet is the executive director of the SESAR Joint Undertaking. Two years ago, at EIWAC2017, he gave a presentation entitled, "Toward a digital aviation infrastructure." At EIWAC2019, his speech started with why the digital transformation of air traffic management is necessary. Then, he discussed how SESAR intends to introduce the digital transformation, some of the solutions for this that SESAR has developed in Europe, and some of the remaining challenges.

He started with why. The world around us is changing very fast. He mentioned three emerging changes. First, environmental protection is becoming an important topic. In Europe, there are strong demands to mitigate the impact of aviation on the environment. Second, air traffic in Europe is expanding year on year. This is bringing with it ever larger numbers of delayed, canceled, rerouted, and rescheduled flights. Third, new technologies such as robotics, data analytics, artificial intelligence, communication, and connectivity are emerging and changing not only our daily lives but also aviation technologies and air traffic management. To accommodate these changes, Europe needs a bold vision that embraces the digital transformation of aviation.

He discussed how digital transformation will be achieved. He introduced many of SESAR's challenges in the presentation, but two key issues here are ATM architecture and automation. The SESAR master plan proposes a new architecture. The new architecture includes not only current airspace but also new airspace operations, such as higher airspace operations and U-space operations. The new architecture has the characteristics of a fully scalable system with strong air-ground integration. Also, the architecture should rely on a digital ecosystem, the elimination of environmental inefficiencies caused by the aviation infrastructure, and ensuring that it offers solutions that will fully exploit the potential offered by next-generation aircraft for cleaner and quieter flight. The second key technology for digital transformation is automation.

The master plan has developed an automation model and roadmap. The automation will mainly come from robotics, not ATM. Automation in ground and airborne locations will have to be applied in a highly safety-critical environment like ATM and aviation. In addition to automation, visualization, connectivity, and data sharing will be key technologies in the aviation and ATM of the future.

In conclusion, Mr. Guillermet highlighted three essential points for succeeding in the digital transformation of air traffic management. First, environmental impact is a huge threat to the full aviation system in Europe. This means the significant challenge of achieving a system where not a single drop of kerosene is wasted in the entire flight, and in the entire system, be it in the air or on the ground. The second point was that adapting the current system that uses old technologies or extending the current technologies will not be sufficient for digital transformation.

People can already see the behavior and performance that the aviation systems need. To continue the aviation success story, it will be necessary to consider not only traffic growth but also other factors like new threats (cyberthreats) and societal challenges. The third point was that we acknowledge somehow that this is something that combines not just innovation and industrial action, but also governmental action. He talked about sovereignty. The things that control the skies of the future will not be the same as the systems we have today. All governments need to invest in those technologies if they want to remain in control of what's flying in the future, because a lot will of it will be done through information management. If they don't control the information, they won't control what's flying in the future.

In addition to these three points, he also gave the audience some vital messages at the end of his presentation. Digital transformation can proceed through bilateral or multilateral cooperation between the various regions. The standardization body plays a key role in this respect, because technology is growing fast and accelerating. The only way we can keep up the pace in terms of the regulatory environment is to link it with industry standards that are performance-based and not focused on technology.

3.3 Christopher Loring, "Moving Innovation to Implementation"

Mr. Loring is the manager of the International Division in the FAA's NextGen Collaboration and Messaging Office. In his presentation, he spoke about the situation and perspectives regarding the FAA's NextGen program on behalf of Ms. Pamela Whitley, the Assistant Administrator for NextGen at the FAA. The Next-Generation Air Transportation System, or NextGen, is the FAA-led modernization of the air transportation system in the United States. The aim is to make flying even safer, more efficient, and more predictable.

Mr. Loring began by reported that they were now at the stage of taking NextGen beyond the R&D and incremental development phase, and moving it into full implementation. Many lessons were learned along the way. For example, there were mismatches between the plans and reality—some of the plans were too aggressive. They also learned that politics played a much larger role than they had thought. While it made sense to develop a plan to close or consolidate certain facilities and equipment based on efficiencies gained through the modernization plans, the political realities did not align with this, and they had to change the plans. The people side is just

as important as technology. This was an important lesson learned—to gain the trust and garner the commitment of multiple partners to work together to develop a global approach to modernization and of stakeholders to achieve everyone's common goals.

At ICAO's 40th assembly, he saw that many countries understand the need to participate in and be interoperable with a global air traffic management modernization plan, and many are just beginning the planning phase for doing so. Some countries have begun their modernization programs, and some are looking to move toward more advanced concepts, like broader PBN implementation, ADS-B or system-wide information management. It is clear that we in the ATM R&D community need to help countries understand where we have been, what lessons we have learned, and where we are going.

Speaking of goals, the culmination of the NextGen programs, processes, and procedures will be the holistic implementation of trajectory-based operations as proposed in the FAA TBO vision for 2025 and beyond, as well as the ICAO Global Air Navigation Plan. Holistic implementation here means giving strategic consideration to the entire airspace system. It does not mean implementing TBO everywhere. TBO will be implemented where it is required based on the strategic needs of the entire national airspace system, not on the tactical needs of individual airports. For TBO to deliver its anticipated performance benefits, all the capabilities and processes integral to it will need to be developed and deployed in a globally harmonized manner.

As TBO is a comprehensive and holistic concept that incorporates almost every aspect of the global aviation ecosystem, a significant amount of research and development still needs to be done. The FAA is working with the user communities through the NextGen advisory committee to determine the best combination of capabilities to use in a given operational environment. Researchers are evaluating whether the application could increase airspace capacity by delegating spacing and sequencing to the flight deck. Airframe and engine improvements, as well as alternative jet fuels currently in operation or in the research phase, may lead to additional emission and energy benefits in the future. Noise reductions will come from airframe and engine improvements, as well as from changes in aircraft operations.

Mr. Loring pointed out that since information management and communications are significant enablers with regard to all of these considerations, cybersecurity is another important area of research. While the threats are many, new areas of research are producing technologies such as resilient self-adaptation and big data analytics that promise solutions to some of the cyberchallenges. Research will also be done into methods for securing the NAS in an environment where the trustworthiness of some systems is unknown.

The FAA is currently working with NASA on a construct for urban air mobility, or UAM. This includes examining the technological, operational, and regulatory issues that need to be amended or developed in order for UAM to grow. The FAA is developing performance-based rules—including definitions and certifications for the aircraft—to ensure safe integration into a very complex airspace and environment. Also, many of the aircraft are involved in long-duration flights, in addition to existing aircraft, several other supersonic and hypersonic aircraft, and balloons. The FAA is working both internally and with ICAO to develop a global framework for these

operations that utilizes autonomy, automation, and the current regulatory construct to assure safety, while maintaining efficiency.

Finally, Mr. Loring again noted that TBO is an evolutionary realization of ICAO's global air traffic management concept. It is clear that the ATM R&D community needs to understand where it has been and where it is going if it is to help with the global implementation of ATM modernization. According to Mr. Loring's presentation, the biggest lesson when it comes to innovation, R&D, and implementation is to work together to gain the trust and garner the commitment of global stakeholders. "We are no longer individual countries implementing our own programs. We are all in this together," he concluded.

3.4 Tohru Kawaharabata, "CARATS Long-Term Vision for Air Traffic Systems—The Challenge for Implementation of Future Technology"

Mr. Kawaharabata is the director general of the air navigation services department of JCAB. He spoke about four topics related to Japan's long-term vision for future air traffic systems, the Collaborative Actions for Renovation of Air Traffic Systems (CARATS).

The first topic was the future trend of air traffic demand. According to a statistical survey by ICAO, the number of departures will rise to approximately 38 million globally, and world passenger traffic, expressed in terms of total scheduled revenue passenger kilometers (RPKs), will grow by 6.7% to reach approximately 8.2 trillion RPKs. International scheduled passenger traffic expressed in terms of RPKs grew by 6.4% in 2018. In particular, the Asia-Pacific is the fastest-growing region, with an increase of 7.3%. How JCAB is going to deal with this traffic growth is the most urgent and crucial issue. Meanwhile, the number of aircraft flying over the Japanese flight information region is also expected to increase by a factor of 1.5 in the next two decades. In order to achieve continued economic growth in Japan and its neighboring countries, a sufficient air traffic control capacity will be required to support the growing demand, as a kind of aviation infrastructure for such a level of economic activity. In addition, Japan is going to host the upcoming Olympic and Paralympic Games Tokyo 2020. Since the Japanese flight information region covers a large part of the Pacific Ocean, JCAB, as a member of the community of air navigation service providers, is in a good position to take various proactive measures to cope with the surge in air traffic demand in this rapidly growing region. JCAB has been providing the air navigation service with high levels of safety, punctuality, and efficiency for many years by keeping itself up-to-date on the most recent ATC services through appropriate budgetary and staffing measures, in order to meet the demand. On the other hand, since this demand will continue to increase, we will have to improve our current air traffic control system so that it can respond correctly to the changing environment, especially future limitations on airspace and the workload of

air traffic controllers. In addition, various new needs have arisen for air traffic control systems, such as the need for improved user convenience and operational efficiency, and for more economical operations.

The second topic was the future of air navigation. Since aircraft fly across national borders, the global approach is an important concept in the aeronautical transport field. Therefore, an aviation infrastructure that supports air navigation services must provide seamless services to international flights. With this background, and considering the necessity of meeting the growing air traffic demand, ICAO has set the basic direction for internationally harmonized ATM for the year 2025 and beyond in the form of the Global Air Navigation Plan (GANP), a long-term vision for modernizing global ATM operations. Based on this vision, a lot of countries have made their own air navigation plans. It is important to take global harmonization into consideration when making such plans. The new GANP also aims to bring the aviation community together to achieve an agile, safe, secure, sustainable, high-performing, and interoperable global air navigation system.

The third topic was the CARATS. For the national level, JCAB, as the Japanese air navigation service provider, created its long-term vision for the CARATS concept in 2010, with the cooperation of all parties concerned. It aims to renovate air traffic systems to meet the growing demand and needs. In order to improve air traffic systems so they meet the growing demand and a variety of other needs, it will be necessary to have collaboration with stakeholders in air navigation. For the CARATS, all stakeholders, including industry, academia, and the government, have joined together and discussed important issues on a collaborative decision-making basis. Meanwhile, they always keep in mind that in order to ensure international interoperability, it is necessary to cooperate closely with the states concerned. Regarding the content of the CARATS, they have set several goals to be achieved in the framework of the CARATS. Also, each measure for achieving these goals has been implemented step by step. In addition, to clarify the outcome of each item contained in the CARATS, more specific measurable targets have been set for each goal, and the degree of progress is checked on a yearly basis to ensure effective implementation of the CARATS measures. In order to achieve those goals, they will have to carry out drastic reforms regarding the conventional concepts of ATM and basic CNS technologies. The CARATS framework provides eight directions for the reforms, with a focus on the transition to trajectory-based operation as one of the major final targets. The measures for these eight reform directions have been developed within the framework of the CARATS, and are categorized into two groups: one is defined as operational improvements, and the other as enablers of technical factors that will help achieve the reforms. Corresponding to these measures, JCAB has developed roadmaps for the implementation of the operational improvements and the enablers. Before putting each measure into practice, they will verify that it is cost-effective and feasible from various points of view. At the implementation stage, they will review the roadmaps and, if necessary, modify them in response to further changes after the decision to implement. In his speech, Mr. Kawaharabata introduced two CARATS measures: RNP-AR (authorization required) procedures and controller–pilot data link communication (CPDLC).

For his final topic, he spoke about the harmonization of standards. The realization of new technology is indispensable for R&D. Besides this, to ensure interoperability at a global level, an integral requirement is to harmonize the standardization activities. JCAB has participated in experimental programs for system-wide information management (SWIM), such as a Mini-Global Demonstration trial undertaken with the cooperation of countries including the US, Canada, Australia, and Singapore, in cooperation with ENRI.

3.5 Naoki Tanaka, "Challenge, Leading to Growth—Corporate Strategy of Japan Airlines"

Japan Airlines (JAL), one of the representative airlines in Japan, serves about 1000 flights per day to more than 44, 000 million customers, using 235 aircraft. A total of 34, 000 employees welcome international passengers at 95 airports worldwide, taking them to more than 400 destinations all over the world in cooperation with code share partners. To meet the growing demand for passenger transport, especially resulting from the strategic targeting of tourism in Japan, JAL is planning to add a further 100 flights in 2020 in the Tokyo metroplex area—which includes Tokyo International (Haneda) and Narita International airports—while achieving ecologically friendly operations. They have drawn up future visions for sustainable growth in aviation: a mid-term management plan for three to five years and long-term goals for ten years. The year 2020 will be a landmark year because of the Olympic Games and the expansion of the Tokyo metroplex airports. Therefore, JAL has set a target phase called "Challenge, Leading to Growth" for preparing for the Olympic year 2020 and contributing to successful growth beyond it.

They have extended their business domain, the full-service carrier business (in which they have 70 years' of continuous history), to provide their worldwide business services more widely in order to achieve sustainable growth. They began introducing the A350 aircraft (which will replace the B777 as their new flagship) in September 2019. Other projects include creating smart airports, which will minimize passengers' waiting times in the airport area. Self-check-in and baggage drops will be increased at airports in the near future. Moving toward further customer convenience, the key is to increase the networks of routes operated in partnership with other airlines in the OneWorld alliance. Furthermore, joint business with American Airlines, Finnair, and Iberia will improve timetables, fares, and airport connections. Beyond the alliance group, collaboration with Hawaiian, China Eastern, China Southern, Alaska, etc. will aim to connect more than 500 destinations all over the world. JAL has created a new LCC airline, ZIPAIR, which flies B787 wide-body aircraft on long and medium-length flight routes to accommodate rapidly growing demand.

Creating new forms of social value is another important key in JAL's future structure. To promote their innovation process, JAL established "Innovation Lab" in 2018. The Lab members actively work to develop their ideas into social value. For example,

they investigate ways to apply artificial intelligence (AI) to increase the value of precious human resources. Developing AI and robotics to assist with checking counters will enable even better customer service. Recording maintenance logs with smartphone applications will support engineers and enhance the safety and efficiency of their work procedures. Virtual reality (VR) will enable crews and mechanics to raise the precision of their training processes. These technologies will bring about innovation that will add an enormous amount of extra quality to customers' journeys and operational matters in the future. JAL continues to pursue sustainable development of the aviation society all around the world.

3.6 Yoshiaki Tsuda, Akira Fukabori, and Kevin Kajitani, "ANA's Endeavor to Connect All 7.5 Billion People on Earth"

All Nippon Airlines (ANA) started their aviation business as a small startup: their original company was "Nippon Helicopter (NH)," which was a small private helicopter company that started operating with only two helicopters. Currently, 43,000 employees work at ANA, and they offer 1200 flights per day using around 300 aircraft. Behind the company's dramatic growth lies a pioneering spirit that has been passed on to younger generations. In 2016, ANA established "Digital Design Lab (DDL)" as an innovation engine for their entire airline group. Their first approach was to create disruptive business models for airlines. One of their ideas is "avatar" technology, which will enable people to travel all over the world virtually.

The DDL has started to work on pioneering the new avatar technology. What this means is physical avatars: physical robotic systems that will enable us to essentially teleport our presence, senses, and consciousness to a remote location, essentially existing in a place that our bodies are not currently in. Why, then, would ANA, an airline that physically transports passengers, pursue robotic avatar technology—and why now? The reason is that people around the world are still not connected physically by long-distance transfer provided by airline transport. According to an estimate by the DDL's Avatar Division, the impact of airline industry transport on the global economy is a mere 6%. They say that, as the industry that has connected the world over the last 100 years, airlines should be at the forefront of this endeavor again.

"ANA is not simply an airplane operator," they say. Airplanes are not what their main core business is about, but simply the tools that they currently use to provide their services. Their ultimate goal as a company is not to operate airplanes, but to bridge the gaps of distance, time, and culture that exist in our world.

Imagine that you work weekdays in Tokyo and get to go home, three hours north of Tokyo, only on the weekends, but can interact with and go home via avatar whenever you like. And when you log in to your avatar, your wife says "Welcome home" and, "Now you're home, I'm going to watch TV or do a hobby." Then your son says,

"Papa, let's run around the house and play together." And when you log out from the avatar, he hugs you before you leave the robot. Your son is two years old, and as you can imagine, a two-year-old cannot sit in front of a video chat for more than 30 s. But because you are physically present, your son is able to recognize that it is Papa, and you are able to interact with and essentially take time to care for him—and that frees up time for your wife.

Just this year, the World Economic Forum announced their top ten emerging technologies for 2019, and ranked at number six was collaborative telepresence, in which ANA's Avatar initiative was listed. So, this avatar movement is real, and they believe that it is just around the corner and is what the future of avatars will be.

3.7 Shigeru Ozeki, "Innovations for Future Aircraft Operation and Standardization"

After introducing ENRI, Mr. Ozeki, the director general of ENRI, presented the reason why digitalization is under discussion for ATM/CNS, with reference to collective intelligence, or intelligence that grows out of a group. Then, innovation and standardization were discussed, including how collective intelligence works for them. This presentation was based on the fact that operation of an aircraft is supported by the collective intelligence that is formed from the pilot, air traffic controllers, airport operators, dispatchers, weather specialists, engineers, inspectors, lawyers, and many others who work on each aspect of aircraft operation.

The first point in the presentation was that digitalization of ATM/CNS will furnish an environment for having better collective intelligence for aircraft operation. Digitalization will make exchanging knowledge easier, even when the contributors to the collective intelligence for flying are distant in space or time. For example, digitalization will provide automated tools to extract information from data, to communicate or share the information, and to manage it and operations on it. Sharing information among experts in various areas will support finding new knowledge or new combinations of knowledge. We need better collective intelligence to achieve innovation and standardization with new knowledge or new combinations of knowledge in order to overcome the restrictions of conventional air traffic management.

The second point in the presentation was that innovation and standardization may help each other regarding exchanging knowledge among the teams working on innovation. The teams working on standardization may become focal points for various kinds of knowledge to build up the collective intelligence for aircraft operation to be standardized. The teams working on innovation may provide knowledge that is new to the standardization teams. Conversely, the innovation teams may be inspired by the discussions in the standardization teams, because the standardization teams will have a broader range of knowledge than the innovation teams in most cases. This is why the presenter invited representatives from the innovation teams to join the standardization teams.

At the end of the presentation, conformity of strategic direction in each layer of activities was discussed, in order to think about a better environment for collective intelligence to fly in. Strategies have a layered structure. For example, there are ICAO strategies, national strategies, project strategies, and so on. A layer may be an environment or resource plan for other layers. If there is no conformity between the directions of each layer, their perspectives will not be focused on a common future. This will mean the directions for collective intelligence in each layer will not fit in with the others and will be hard to import into the other layers. This kind of environment will be hard to work in.

Conformity of strategic directions among the layers will be necessary for a compatible perspective. To achieve this, coordination within each layer and among layers will be important. One recommended method is participation in multi-disciplinary meetings like EIWAC.

4 Panel Discussion

The panel discussion of EIWAC2019 was held on October 29, 2019, on the theme of "Digitalization in Aviation—A Standardization Perspective." Digital transformation was a key spotlight topic in EIWAC2019, and the objective of the panel discussion was to bring together leaders involved in regulatory and standardization activities to share their expertise in facing challenges and developing strategies to consolidate different approaches to achieving this global objective.

Panelists:

- Mr. Stephen P. Creamer (Director of Air Navigation Bureau, ICAO)
- Mr. Christian Schleifer-Heingärtner (Secretary General, EUROCAE)
- Mr. Terry McVenes (President and CEO, RTCA)

Moderators:

- Mr. William C. Johnson (Senior Aircraft Engineer, NASA Langley Research Center)
- Mr. Hajime Yoshimura (Senior Air Talks Officer at JCAB, MLIT)

Mr. Johnson commenced the panel discussion with an overview of its theme and objective. The event included two presentations by Mr. Schleifer-Heingärtner and Mr. McVenes, followed by a discussion that included a Q&A session with the audience.

Mr. Schleifer-Heingärtner's presentation focused on EUROCAE activities on standardization methodologies and its strategies for keeping up the pace of standardizing the new technologies and innovations being introduced into the aviation community. He discussed the workflow for deployment of such technologies and how a regulatory framework is supported and complemented by standards during the process. He emphasized the challenges regarding addressing new-entrant technologies in a timely manner while maintaining the core values of being open, transparent,

and census-driven, without compromising safety. He stressed the fact that a regulatory framework is not always the basis for developing standards. He suggested that the best kind of driven approach is an industry-driven initiative, where the standards-developing organizations can support it with their knowledge and experience in order to move it forward and achieve its objectives in an efficient and effective manner. He also implied that his organization is risk-based, operation-centric and has a performance-based regulatory framework, but doesn't draw any conclusions about whether the standards it defines provide any technical solutions, because the products possess minimum operational performance standards.

Mr. McVenes commenced his presentation with an introduction to RTCA and its role in the world of standardization. RTCA has developed about one-hundred MOPS and more than thirty MASPS since its inception, and these have been referenced by over 100 FAA regulations advisory circulars or technical standard orders and more than fifty ICAO SARPS. He mentioned the commitment of RTCA to bringing industry and government together and working with international partners to develop and increase the efficiency of the air traffic system. He clarified Mr. Schleifer-Heingärtner's remarks by pointing out the importance of collaboration between standards-developing organizations for achieving harmonization as an aviation community. Mr. McVenes noted that using a consensus-based process to develop standards that are not only technically complete but also operationally effective is crucial to ensuring that the new technologies can be integrated into the system through those standards in a much quicker time. RTCA is currently working with FAA to develop MOPS that are scalable in terms of meeting the safety criteria based upon the operation. He stressed the fact that standards-developing organizations must be very adaptable, need to increase their pace, and have to expand their ways of thinking in terms of looking at different aspects of aviation, without compromising on safety in any way. He concluded his presentation by saying that working together with EUROCAE and ICAO is so vital for the industry because the harmonization and interoperability that these organizations must have through its standards is vitally important.

The discussion session was commenced by Mr. Johnson by raising the issue of how the standards-developing organizations are working to close the gap between vehicle manufacturers and standards, given that new entrants in aviation have short lifespans with rapidly evolving technology, while standards might take years to introduce. Mr. Schleifer-Heingärtner noted that these organizations are well aware of the current trend in the aviation markets and the needs of the industry, and supported the strategy of scalable standards mentioned by Mr. McVenes. He also emphasized however that standards must be consensus-driven and ensuring safety is paramount, and that these will require time. Mr. Terry suggested that early engagement with the industry will be important to help bring new technology to the market swiftly. He also said that collaboration between standards-developing organizations will be vital to shortening the cycle time of the standardization process and avoiding unnecessary waste of resources due to lack of communication between these entities.

Mr. Creamer joined the discussion by talking about the safety of air transport and how the standards have helped to create such confidence in users. He said that risks

related to air transport have not been completely eliminated, but are being managed and the management process is built on over a hundred years of experience. He compared examples to show the difficulty of leaping toward a customer-based standardization process and emphasized the potential benefits approving new technologies could bring to users in need, for example, providing the capability to deliver blood to a clinic located 100 km away within a few minutes' time. He was also willing to share the idea that the aviation world is going to see a steady evolution rather than a revolution through digitalization, and the possibility of creating a parallel set of regulatory provisions and mastering its evolution so that new industries can co-exist and operate within traditional air transport. Mr. Creamer confirmed the position of ICAO on the process of regulating standards in a purpose-specific and efficient manner.

Regarding the question raised by Mr. Yoshimura on the possibility of shortcutting any process to speed up the regulatory framework, Mr. McVenes commented that getting a new entrant certified in a timely fashion without compromising safety is quite challenging, and stressed how these organizations have achieved the safety criteria deliberately, step by step and sometimes by using lessons learned through tombstone mentality. Mr. Schleifer-Heingärtner added that regulatory procedures are streamlined and in good order to deliver on time. He also noted a new suggestion developed with the SESAR Joint Undertaking to have a direct link when R&D activities are conducted. He stressed however that these procedures will need lot of coordination and verification before being certified. Mr. Creamer added that if an industry understands how to identify and manage risk, the outcomes will potentially be approved in a regulatory sense in a local environment, but the products must be demonstrated at a local level before being certified for the global market.

One question raised during the Q&A session was the challenges faced by the aviation community due to a performance-based regulatory framework. Mr. Creamer showed how crucial it is to implement a solid functional hazard analysis and risk assessment followed by cataloging and implementing mitigation measures by a regulator, in order to ensure that the right decisions are made for safety management. Another question was from the airline operational domain and concerned the trust framework of ICAO and what it expected from the standards-developing organizations to ensure that users are operating within that framework. The panelists agreed that trust is the key to ensuring interaction between different bodies that could eventually lead to achieving greater heights and overcoming more challenges in the aviation world.

Mr. Johnson concluded the panel discussion by stating that it had demonstrated that there was an important need for aviation operators, users, and manufacturers to work closely with standards-developing organizations to fulfill the demands of both traditional and emerging aviation markets, and that it had also had shown how those operations and markets could evolve together into a common ecosystem while ensuring the safety and efficiency of their systems. The digitalization of aviation holds challenges for everyone, so everyone must work together to enable aviation to undergo its next evolutionary change.

5 Special Speeches

This section summarizes the special speeches given in EIWAC2019. EIWAC2019 included a one-hour speech from EUROCAE on day two, and a speech from DSNA on day three.

5.1 Christian Schleifer-Heingärtner, "Current and Future Aviation Standards—Shaping Global Standards Through Collaboration"

Mr. Schleifer-Heingärtner is the secretary-general of EUROCAE. In his presentation, he introduced the EUROCAE association's current situation, then spoke about its current domains of activity and new activities.

First, he introduced the current situation regarding EUROCAE, which is a standardization body based in the EU: as of 2019, it has 300 members, 40 active working groups, and 2500 experts. EUROCAE has seen a minimum of 10% growth per year for the last six years. Its members are from industry, manufacturers, parts manufacturers, equipment manufacturers, engine manufacturers, aircraft manufacturers, and ground infrastructure manufacturers for ATM sites. Coordination and collaboration with many stakeholders in aviation are important to developing standards. EUROCAE does 50% of its activities jointly with RTCA and 10% with SAE. It is one of the standards-developing organizations recognized by the international standards-developing organization at ICAO. Mr. Schleifer-Heingärtner explained the standard-developing process adopted by EUROCAE. They believe that the development process should be transparent and open to the public.

Second, he introduced EUROCAE's current domains of activity. These are Avionics, Communication, Navigation, Surveillance, ATM Systems, Airports, SWIM, Electric (lightning protection/high-voltage), Security, AIS/MET, RPAS/VTOL&GA, and Miscellaneous (fuel cells, hybrid propulsion, space, ice detection, C-UAS, N-GAP).

Then, he went into detail about some of the working groups. For example, EUROCAE developed the Flight Tracking and Return Link Service in WG-98 Aircraft Emergency Locator Transmitters. An initiative by ICAO called Global Aeronautical Distress and Safety System (GADSS) arose from the disappearance of Malaysian Aircraft 370. GADSS is about tracking or having a position when an aircraft is in distress. One of the GADSS solutions is EUROCAE ED-62. EUROCAE updated the emergency locator transmitter standard, so it is now ED-62B. WG-98 is a good example of a joint activity EUROCAE conducted with RTCA. Mr. Schleifer-Heingärtner also went into detail about the following: WG, WG-100 Remote/Virtual Tower, WG-109 RWIS (Runway Weather Information

Systems), WG-111 A-CDM, WG-105UAS, WG-115 C-UAS, WG-112 VTOL, WG-113 Hybrid Electric Propulsion, WG-72 Aeronautical Systems Security, and WG-114 Artificial Intelligence.

Third, he talked about the following new activities conducted by the technical working program in 2020:

- Digitalization, digital transformation and big data
- AI and blockchains
- Automation and autonomous flying
- Virtualization: virtual centers, virtual towers and augmented reality
- Drones, UAS, RPAS, and UTM
- Counter drone technology
- Urban air mobility and flight taxis (VTOL pilot project)
- Urban CNS and GNSS/ GSM performance in urban areas
- ATFM and civil/military applications
- Health monitoring and predictive maintenance
- Single pilot operations
- Computer vision
- Quantum computing
- Air-to-air connectivity
- Higher airspace operations
- Electronic conspicuity
- ATM data service providers
- Ground-handling
- Environmental activities
- Hybrid electric technologies
- Space travel
- Space-based solutions.

In conclusion, he emphasized the importance of shaping global standards through collaboration. In order to achieve global interoperability, EUROCAE will need participation from all over the world. That contribution will lead to globally applicable standards.

5.2 Patrick Souchu, "Sharing Trajectory Views: The Key Enabler for Trajectory-Based Operations"

Mr. Souchu is the SESAR program director at DSNA (the French Air Navigation Service Provider). The title of his presentation was, "Sharing trajectory views: the key enabler for trajectory-based operations." Current ATM operations have different views of the same trajectory. This is because each stakeholder has different needs, and these views often differ for various reasons. This will not be acceptable if ATM users are to use these trajectories for more advanced capabilities. Stakeholders should

share a common trajectory. Mr. Souchu discussed three steps toward overcoming this problem in Europe.

The first step is flight plan adherence recommendation. In Europe, many flight plans differ from the actual trajectories. In 2017–2018, the EUROCONTROL network manager and service providers issued a recommendation calling for improved flight adherence to flight plans, to not only on the part of the airlines but also of the controllers. This is because if a controller give a direct route, then it will affect many other sectors. The controller may not be aware of the impact on other sectors, especially in terms of congestion. This recommendation was therefore issued and has been implemented through collaboration between airlines and CFSPs, and between airlines and ATCs.

The second step is sharing information on the ground by means of FF-ICE and IOP of flight objects. The ICAO FF-ICE initiative will facilitate the sharing of enhanced flight information in the planning and execution phase. As an instance of this FF-ICE concept in the execution phase in particular, SESAR is currently addressing this sharing of flight information with the notion of flight object interoperability, something that was initially defined in EUROCAE document ED-133. At the ATC level, IOP will improve safety and capacity. It will ensure a constant and consistent view of all traffic flows, even those processed by other flight data processing systems. It will reduce the ATCO workload because of better traffic anticipation. It will allow more enhanced and efficient coordination compared with all the current standards in Europe. It will enable more enhanced and efficient negotiation with downstream units compared to current voice negotiation and will improve the performance of conflict detection and resolution tools. At the ATFM level, it will also contribute to significant improvements in trajectory consistency and trajectory accuracy, and thereby allow us to reduce the uncertainty buffer. It will therefore improve the predictability and performance of the demand and capacity balancing.

The third step is sharing information between the air and ground. One of the first examples of air-ground coordination is the use of a selected flight level, which is transmitted by Mode S enhanced surveillance and already provides large safety benefits. Another example is the downlinking of aircraft's extended projected profiles (called EPPs). EPPs are computed and updated onboard, and transmitted by Automatic Dependency Surveillance Contract (ADSC) using a standard called ATN B2. There are plenty of potential uses for these onboard trajectories, but large safety gains can be expected if they are used to highlight possible discrepancies between the airborne trajectory computed by the FMS and downlinked and ground-based trajectories computed by the flight data processing system.

In conclusion, he pointed out that for various reasons, trajectory views are not always consistent today. This could result in safety issues and inefficiency, and impose serious limitations on moving to trajectory-based operation. However, three steps will lead to sharing of views. The enhanced ground-ground sharing of information via FF-ICE and flight object interoperability and the new air-ground data link capabilities for sharing air and ground trajectories using ATN B2 are almost there. Finally, sharing views will enable trajectory-based operation.

6 Conclusions

The sixth ENRI International Workshop on ATM/CNS (EIWAC2019) was held in October 2019 with the aim of comprehensively sharing information on the latest ATM/CNS technologies and operations among the participants, and seeking potential partners for R&D, standardization and global harmonization activities.

This chapter began with a history and overview of the EIWAC series. It then summarized the topics and opinions presented by the keynote and special speakers, who were from various organizations, among them regulators, standardization bodies, ANSPs, operators, and R&D organizations. The keynote and special speeches showed that the speakers had a common awareness regarding the problems facing current aviation systems. Digitalization and emerging technologies will be key solutions to these problems.

References

1. EIWAC2009 homepage, https://www.enri.go.jp/eiwac/2009/en/index.html
2. EIWAC2010 homepage, https://www.enri.go.jp/eiwac/en_EIWAC2010siryou.html
3. EIWAC2013 homepage, https://www.enri.go.jp/eiwac/en_EIWAC2013siryou.html
4. EIWAC2015 homepage, https://www.enri.go.jp/eiwac/eiwac_2015_eng.html
5. EIWAC2017 homepage, https://www.enri.go.jp/eiwac/eiwac_2017_eng.html
6. EIWAC2019 homepage, https://www.enri.go.jp/eiwac/eiwac_2019_eng.html
7. Electronic Navigation Research Institute, Ed., Air Traffic Management and Systems (Springer, 2014), pp. 3–14
8. Electronic Navigation Research Institute, Ed., Air Traffic Management and Systems II (Springer, 2017), pp. 3–24
9. Electronic Navigation Research Institute, Ed., Air Traffic Management and Systems III (Springer, 2019), pp. 3–15