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Research Paper

Future of Airport Security

Toward the Realization of Smart Security

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Introduction

The annual number of air travelers worldwide has already exceeded 4 billion. According to the International Air Transport Association (IATA), it could double to 8.2 billion per year by 2037.[1] Amid these circumstances, airport operators are facing issues associated with increasing traffic volumes and congestion of passengers. There have also been increasing threats to civil aviation. For example, the detection of explosives, such as improvised explosive devices (IEDs), is a pressing issue. To address these threats, it is necessary to enhance security screening. However, inefficient security screening impedes passenger flow at screening checkpoints, causing a long line of people and forcing them to endure a long waiting time. Airport operators are responsible for improving the passenger experience and expected to implement measures to avoid imposing an excessive burden of security screening on passengers. In response, Airports Council International (ACI) recommends the "Smart Security" program, an initiative that aims to minimize the burden of screening procedures on passengers, to allocate security resources based on risk, and to optimize airport facilities. With the program, ACI aims to strengthen security, increase operational efficiency, and improve the passenger experience as shown in the table below:

The vision of smart security

Strengthened security	*Increased operational efficiency*	*Improved passenger experience*
Focus resources based on risk, increase unpredictability, make better use of existing technologies, and introduce new technologies with advanced capabilities as they become available	*Increase throughput, optimize asset utilization, reduce cost per passenger, and maximize space and staff resources*	*Reduce queues and waiting times and use technology for less intrusive and time-consuming security screening*

Source: https://aci.aero/about-aci/priorities/security/smart-security/

As the number of air travelers is increasing, it is indispensable for airport operators to seek to achieve Smart Security in order to prevent a passenger screening checkpoint from becoming a bottleneck. In this paper, I will discuss the benefits, challenges and solutions of each approach, with a focus on the following four efforts that are currently drawing attention and being promoted in the aviation security field to achieve Smart Security: 1) risk-based security, 2) advanced screening technology, 3) one-stop security and 4) off-airport handling.

[1] https://www.airlines.iata.org/news/passenger-numbers-to-hit-82bn-by-2037-iata-report

1. Risk-based Security

1.1 Overview of the risk-based security concept and its benefits

Risk-based security is an approach to effective and efficient security screening of air travelers. In this approach, information on passengers is analyzed in advance for risk assessment to differentiate passengers into “trusted” and “unknown.” Trusted passengers are considered as low-risk passengers and are allowed to undergo simpler security screening than usually required. Unknown passengers are, on the other hand, considered to be either unknown or high risk and are required to undergo standard screening and, if deemed necessary, an additional inspection. It is extremely difficult to identify a person plotting a terrorist attack or other illegal act among billions of air travelers worldwide. Therefore, in terms of effective use of limited resources, it is quite reasonable to require high-risk and unknown passengers to undergo full security screening. In the risk-based approach, more screening resources are allocated to higher risk passengers to enhance security, while low-risk and trusted passengers are allowed to go through expedited security screening lanes, which helps improve their passenger experience. With these benefits taken into account, risk-based security is an effective tool to realize Smart Security. The next section introduces an example of effective use of a risk-based approach in security screening in the United States.

1.2 TSA Pre✓®program

The screening process of the U. S. Transportation Security Administration (TSA) has evolved from a post 9/11 one-size-fits-all security approach to an intelligence-driven, risk-based strategy.[2] Its notable efforts include the launch of the TSA Pre✓® program in 2011. If you provide information necessary for security vetting and apply for TSA Pre✓®, after a successful background check by the TSA, you can register for TSA Pre✓®. Registered TSA Pre✓® passengers, who are regarded as trusted, can enjoy the benefits of TSA Pre✓®. They are allowed to use a dedicated TSA Pre✓® lane (expedited screening lane) and are exempt from full screening, which requires passengers to remove their shoes and belt and remove their laptop from their bag (See the table below). According to data released by the TSA,[3] more than 7 million travelers have enrolled in TSA Pre✓® to date and nearly 93% of passengers in TSA Pre✓® lanes wait less than five minutes and receive expedited screening. The TSA intends to further promote the TSA Pre✓® program and increase trusted passengers in order to make the security screening process more efficient and effective.

2 https://www.tsa.gov/press/factsheets/risk-based-security

3 https://www.tsa.gov/precheck

Comparison between one-size-fits-all security approach and risk-based strategy

One-Size-Fits-All Approach	*Risk-Based Security Practice*
・All passengers	*・TSA Pre✓®participants, including DHS Trusted Travelers* *・Seniors 75 and older* *・Children 12 and younger* *・Members of the U.S. Armed Forces, including those serving in the National Guard and reserves* *・Cadets and midshipmen of the U.S. Military Academy, Naval Academy, Merchant Marine Academy*
Before, travelers had to remove: *・Shoes* *・Belts* *・3-1-1 liquids bag* *・All outerwear* *・Laptop from bag*	*Now, most travelers may retain:* *・Shoes* *・Belts* *・3-1-1 liquids bag* *・All outerwear* *・Laptop from bag*

Source: https://www.tsa.gov/press/factsheets/risk-based-security

1.3 Challenges and solutions in risk-based security

Challenges in adopting a risk-based approach to security screening include how to collect passengers' information and the methodology for risk assessment based on collected information. In Japan, for example, how to collect information necessary for risk assessment is a challenge because the law strictly regulates the use of personal information. It is also necessary to give due consideration to the methodology for risk assessment to differentiate between trusted passengers and unknown passengers. While it is the responsibility of government agencies, such as the Civil Aviation Authority (CAA), to address these issues, including decision making on whether to adopt the risk-based approach, I would like to propose a solution here.

I think the keys to adopting risk-based security are advanced passenger information (API) and passenger name records (PNRs). Airlines in Japan collect API and PNR data and provide them to government agencies. I think it is possible that the CAA and intelligence agencies use these data effectively in compliance with privacy protection regulations. If methods for risk assessment and best practices that are used by the TSA and other security agencies in other states where the risk-based approach has been adopted can be shared between nations through the ICAO and other international bodies and thereby a standard risk assessment method can be established, it would be possible to spread the risk-based approach globally. The evolution from a one-size-fits-all security approach, which is generally used at present for all passengers worldwide, including in Japan, to a risk-based security approach, which focuses heavily on unknown passengers, will enhance aviation security, improve operational efficiency and contribute to significantly improving the passenger experience. This move is indispensable to realize Smart Security. In introducing a

risk-based approach in security screening, industries should be more active in supporting the adoption of the approach in cooperation with international organizations and national governments by offering their ideas and promoting the adoption of risk-based security in many states, instead of merely relying on states and international organizations.

2. Advanced Screening Technology

To realize Smart Security, it is essential to actively use advanced screening technologies. This section introduces advanced technologies that are the current focus of attention in the aviation security industry and describes their benefits, challenges and solutions.

2.1 Computed Tomography (CT) system

Computed tomography (CT) technology similar to the one used in the medical field has been used for X-ray scanning of hold baggage. As a result of technological innovation in recent years, airports have started using CT technology also in X-ray screening of cabin baggage. Conventional X-ray equipment generally used at screening checkpoints at airports worldwide uses 2-D images displayed on the monitor. CT technology creates a 3-D image that can be viewed and rotated 360 degrees for a thorough analysis and applies sophisticated algorithms for the automatic detection of explosives. In the trial operation of a CT system, which started in 2017, the TSA confirmed the effectiveness of its detection capability and, in 2019, signed a contract for 300 CT systems.[4] Heathrow Airport in the UK has announced a plan to install CT systems at all terminals at Heathrow Airport by 2022, following a trial operation.[5] (According to the latest media report, all major airports in the UK are now required to install CT systems by December 1, 2022.[6]) Some airports in Japan are also adopting CT systems. CHUBU CENTRAIR International Airport (Centrair Airport) installed a CT system at the screening checkpoint and started full-scale operation in 2019. With advanced detection capability, CT systems can significantly contribute to enhancing security. In addition, their capability

CT system installed at the screening checkpoint at CHUBU CENTRAIR International Airport

4 https://www.tsa.gov/news/releases/2019/03/28/tsa-awards-computed-tomography-contract-smiths-detection-inc

5 https://mediacentre.heathrow.com/pressrelease/details/81/Corporate-operational-24/11168

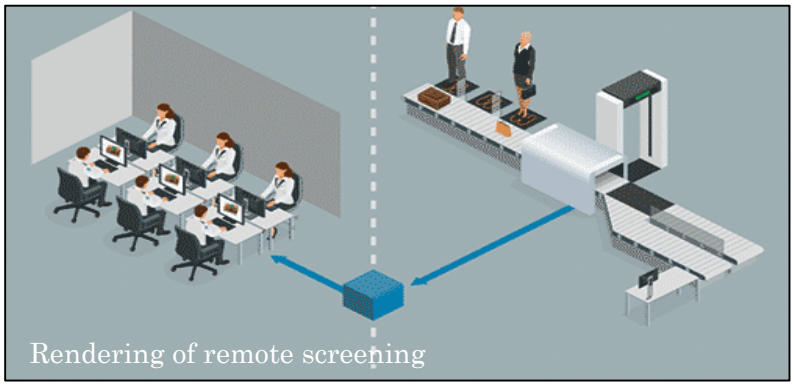
6 http://exclusive.multibriefs.com/content/uk-airports-introducing-new-scanners-to-speed-up-security-screening/civil-government

to automatically detect explosives and easily analyzable 3D real images provided by them help reduce the burden on security screeners, allowing them to focus on analyzing unclear or suspicious images and objects with higher potential risk. Some CT systems have been evaluated as meeting either Standard C2 (Allows screening of baggage containing portable computers and other large electrical items) or Standard C3 (Allows screening of baggage containing portable computers and other large electrical items and LAGs), which are performance standards for explosive detection systems for cabin baggage defined by the European Civil Aviation Conference (ECAC).[7] In the near future, it is expected that travelers can go through a security checkpoint without removing their laptop and/or liquid from their cabin baggage and that there will be no restriction on the amount of liquid they can carry on, increasing throughput at the checkpoint and improving the passenger experience.

2.2 Automated Screening Lane (ASL)

An automated screening lane (ASL) is generally installed with an automated tray return system (ATRS) and a parallel loading system. This is a solution that can realize Smart Security. ASLs are currently used widely at airports around the world. It is a known fact that an ATRS contributes to reducing the burden on security screeners and parallel loading contributes to increasing passenger throughput. Centrair Airport has benefited from this type of lane. Before the airport implemented ASLs in 2019, the throughput per lane during the peak period was about 250 persons per hour. After the introduction of ASLs, the throughput drastically increased to about 350 persons per hour.

X-ray images can be uploaded from the X-ray search workstation by scanning a tray unique identifier of the RFID tag. This technology is applied to an ASL connected to the Centralized Image Processing (CIP) system to realize remote screening of cabin baggage. In usual X-ray screening of cabin baggage, an X-ray operator sitting next to the X-ray equipment analyzes images. In remote screening, X-ray images can be sent to the remote screening room in real time through networking of multiple X-ray equipment. This remote screening system allows X-ray operators to analyze X-ray images that are sent to the remote screening room from any lane. With this system, cabin baggage can be screened effectively by a fewer number of operators, resulting in the optimization of human resources. In addition, the security screening performed remotely from the screening checkpoint helps security screeners to concentrate more on analyzing X-ray images. Remote screening of cabin baggage is already used extensively at airports around the world and its benefits have been proven. In Japan, however, no airports have so far implemented remote screening of cabin baggage. The adoption of



Source: Aviation Security International

[7] https://www.ecac-ceac.org/cep

remote screening requires significant investment in facilities, such as renovation of existing security checkpoints. Despite such a huge burden, once the investment is completed, the airport can gain significant benefits. In order to realize highly beneficial Smart Security, as many airports as possible, including those in Japan, should be encouraged to adopt remote screening.

2.3 Artificial Intelligence (AI)

In recent years, technological innovation in artificial intelligence (AI) has been promoted in all industries. Areas in which AI is heavily used include transportation, finance, healthcare and logistics. I think that AI is also best used in the aviation security field because the following features of AI are particularly useful for security screening: AI can learn from data (machine learning) and can make predictions based on knowledge. In the airport industry, there has already been a move to adopt AI in security screening. As an example, this section describes an approach taken by Synapse, a U.S. startup company. Synapse develops AI software for X-ray equipment. According to its official website, Syntech ONE®, an AI-powered software platform developed by Synapse, can automatically detect weapons, knives and other threats using AI technology. The article below is an excerpt from a press release on the features of the product on the company's website:[8]

"*Instead of relying solely on human screeners to identify threats, Syntech ONE augments and automates the detection of multiple dangerous weapons and items using state of the art artificial intelligence and computer vision.*"

This press release also mentions that Syntech ONE® was adopted in 2019 for screening of cabin baggage at security checkpoints at Kansai International Airport. While it is unclear about the detection capability and precision of this AI software, it is considered that its function of automatic detection of threats is effective in enhancing aviation security to some extent. Below is a description of machine learning, one of the features of AI, provided in the press release:[9]

Source: SYNAPSE TECHNOLOGY CORPORATION

"*Synapse's AI platform also leverages "big data" techniques to provide frequent enhancements, including additional machine capability and additional item detection*"

Continuing learning using big data and enhancing prediction capability (in other words, improving detection capability) is what artificial intelligence is good at. It is expected that detection capability will

8 https://www.prweb.com/releases/synapse_technology_launches_first_ever_commercial_artificial_intelligence_threat_detection_platform_for_security_x_ray_machines/prweb16145733.htm

9 The same as above

continue to improve. If it is proven that AI is truly useful for security screening in research conducted, for example, by the TSA and ECAC, the use of AI will rapidly be spread throughout the world. Then, the burden on X-ray operators would, obviously, be reduced significantly. Furthermore, the time may come when X-ray operators will not be needed any more.

I would also like to mention here a facial recognition system in association with AI. Facial recognition technology is already widely used particularly for immigration formalities. In recent years, at some airports, passengers can register their facial image upon checking in and can later go through the security checkpoint and the boarding gate without showing their boarding pass and passport. This facial recognition technology can obviously improve passengers' convenience. In addition, in the future, it would become possible to differentiate instantly between trusted and unknown passengers by linking a facial recognition system to a facial recognition system.

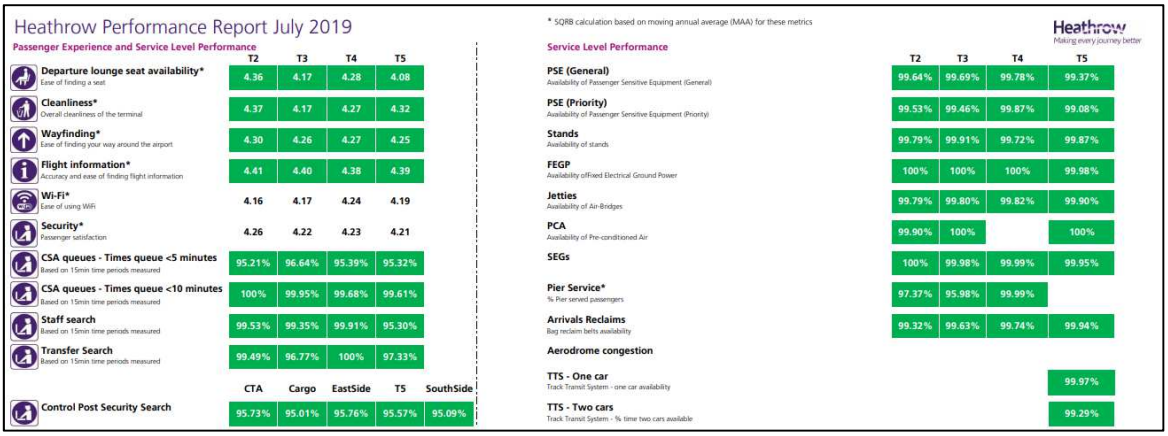
2.4 Challenges and solutions in advanced screening technologies

A major challenge in introducing advanced screening technology in security screening is large capital investment for facilities. For example, the procurement costs of a CT system are much higher than those required for conventional X-ray equipment. In addition, if there is not a space large enough to install an ASL at the existing security checkpoint, it is necessary to expand the space. To introduce remote screening, it is necessary to construct a CIP system and add a new remote screening room. This will require large costs, which place a significant financial burden particularly on small-scale airports. In Japan, a subsidy system funded by the Ministry of Land, Infrastructure, Transport and Tourism is available for industries to purchase these equipment. I think this kind of government scheme to support industries is very effective in promoting Smart Security. There is another system called the Service Quality Rebate Scheme, which is designed to secure financial resources to be invested in facilities and has been adopted by Heathrow Airport in the UK. I find this scheme very interesting. According to the official website of Heathrow[10], the Service Quality Rebate Scheme is explained as follows:

"*The Service Quality Rebate Scheme was introduced by the CAA to identify the service standards that airlines and passengers could expect from Heathrow in return for the regulatory charges they paid. Where performance falls below a certain level, Heathrow must repay a proportion of charges levied back to the airlines.*"

"The service standards" include wait times of passengers at security checkpoints. The monthly performance results are published on the official website as follows:

10 https://www.heathrow.com/company/company-news-and-information/performance/airport-operations/service-quality-rebate-and-bonus-scheme



Heathrow Performance Report July 2019

Passenger Experience and Service Level Performance

	T2	T3	T4	T5
Departure lounge seat availability* Ease of finding a seat	4.36	4.17	4.28	4.08
Cleanliness* Overall cleanliness of the terminal	4.37	4.17	4.27	4.32
Wayfinding* Ease of finding your way around the airport	4.30	4.26	4.27	4.25
Flight information* Accuracy and ease of finding flight information	4.41	4.40	4.38	4.39
Wi-Fi* Ease of using WiFi	4.16	4.17	4.24	4.19
Security* Passenger satisfaction	4.26	4.22	4.23	4.21
CSA queues - Times queue <5 minutes Based on 15min time periods measured	95.21%	96.64%	95.39%	95.32%
CSA queues - Times queue <10 minutes Based on 15min time periods measured	100%	99.95%	99.68%	99.61%
Staff search Based on 15min time periods measured	99.53%	99.35%	99.91%	95.30%
Transfer Search Based on 15min time periods measured	99.49%	96.77%	100%	97.33%

	CTA	Cargo	EastSide	T5	SouthSide
Control Post Security Search	95.73%	95.01%	95.76%	95.57%	95.09%

* SQRB calculation based on moving annual average (MAA) for these metrics

Heathrow
Making every journey better

Service Level Performance

	T2	T3	T4	T5
PSE (General) Availability of Passenger Sensitive Equipment (General)	99.64%	99.69%	99.78%	99.37%
PSE (Priority) Availability of Passenger Sensitive Equipment (Priority)	99.53%	99.46%	99.87%	99.08%
Stands Availability of stands	99.79%	99.91%	99.72%	99.87%
FEGP Availability offixed Electrical Ground Power	100%	100%	100%	99.98%
Jetties Availability of Air-Bridges	99.79%	99.80%	99.82%	99.90%
PCA Availability of Pre-conditioned Air	99.90%	100%		100%
SEGs	100%	99.98%	99.99%	99.95%
Pier Service* % Pier served passengers	97.37%	95.98%	99.99%	
Arrivals Reclaims Bag reclaim belts availability	99.32%	99.63%	99.74%	99.94%
Aerodrome congestion				
TTS - One car Track Transit System - one car availability				99.97%
TTS - Two cars Track Transit System - % time two cars available				99.29%

Source: Service Quality Rebate and Bonus - July 2019 by LHR Airport Limited

Some airports in Japan collect a passenger security service charge (PSSC) from passengers and a security fee from airlines, which are used for improving airport security. There are, however, no schemes like the one adopted by Heathrow Airport, where the airport operator is committed to ensuring the service levels that are expected from airlines and passengers. The higher the PSSC and the security fee collected, the more investment available for facilities. However, if airport operators raise charges and fees without external consent, they will, of course, receive disapproval and will not win public understanding. In this regard, the Service Quality Rebate Scheme is a method that both the airport operator and airlines/passengers can accept in that the operator collects charges necessary to fulfill the service level expected by airlines and passengers and, if the operator fails to meet the level, the charges will be repaid. This approach shows that the service provider is committed to serving the recipients of its services, which, I think, makes it easier to secure sufficient financial resources. I think this is a noteworthy method to effectively obtain sufficient financial resources to be invested in facilities.

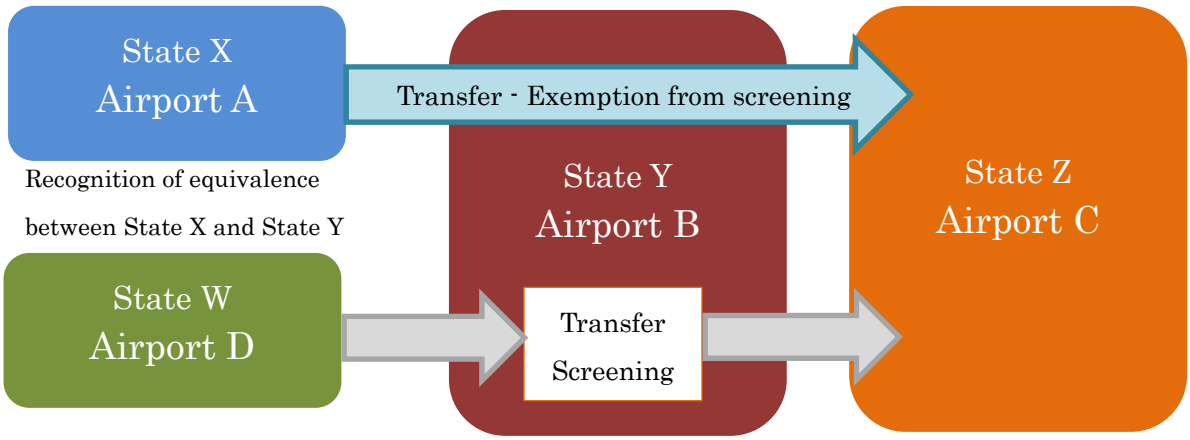
The next topic I would like to discuss is a challenge associated with certification of various detection devices and technologies that have newly been developed. There are, for example, walk-through shoe scanners around the world. To use this type of scanner as a primary screening device at a screening checkpoint, the airport operator must obtain certification from the appropriate national authority. Unless the authority approves the effectiveness of the device, the airport operator is not allowed to use it as the primary screening device. The challenge here is that, while artificial intelligence and other technological innovations are advancing at an accelerating pace, the speed of certification cannot catch up with the speed of technological innovation in some states. While the TSA and ECAC have their research center and laboratory to assess the performance of devices, there are some states where no such facilities are available and therefore the performance of devices cannot be assessed. Even if there are very effective devices, without any appropriate national certification system for devices, they will remain unused. Such a situation must be avoided. One of the possible solutions to address this challenge would be for the ICAO to take the initiative in establishing an international standard certification system. However, considering that each state face different threats and risks and, therefore, the performance of each device must meet the requirements

of each country, it is not easy to establish an international unified certification system. To deal with this difficult challenge, more cooperation is needed among the ICAO, states, relevant organizations, industries and other relevant parties.

3. One-stop Security

3.1 Overview of one-stop security and its benefits

Transfer passengers and their cabin and/or hold baggage going to their destination via an airport in a third country are usually required to go through security at the airport in the origin country as well as at the transfer airport. One-stop security is a system that allows transfer passengers and their cabin and/or hold baggage to be exempt from screening at the transfer airport if both departure and transit states recognize that the security standards applied in the two states are equivalent.[11] One-stop security eliminates security screening redundantly performed at the departure and transfer airports and thereby speeds the flow of passengers and their cabin and/or hold baggage at their transfer airport. In this regard, this system is very effective in realizing Smart Security. Those most benefited by this system are transfer passengers. Going through security screening twice, at the departure and transfer airports, is a great burden on them. Exemption from security screening at their transfer airport should significantly contribute to improving the passenger experience. One-stop security is also attractive to airport operators. If there are many transfer passengers, many screeners and security equipment units are necessary at the transfer security checkpoint, which incurs significant costs. The implementation of the one-stop security system would allow resources that are otherwise used for transfer passengers' security screening to be allocated to the installation of advanced screening technologies, training of human resources, and other areas that need greater resources. This will not only reduce costs but also help enhance security screening.



Reference: ICAO Aviation Security Manual

[11] ICAO Aviation Security Manual

3.2 Challenges in one-stop security

As stated above, one-stop security offers many advantages. Despite its high effectiveness, this system has not been widely adopted worldwide. In Japan, Narita International Airport has started one-stop security service but only to a limited extent.[12] Other airports, including Centrair Airport, have not adopted one-stop security. There are some reasons why many airports around the world do not adopt it. One reason lies in many processes that are required before the equivalence of the respective security standards are mutually recognized by the two states. It can be easily imagined that it takes significant time and human resources for states(appropriate authorities) to recognize that their security standards are equivalent to those of other states. I think there is also a factor that inhibits airport operators from adopting one-stop security. To implement one-stop security, they need to separate passengers exempt from security screening (those from a country with standards recognized as equivalent) and those required to go through screening (those from a country with standards that are not recognized as equivalent) at the transfer security checkpoint. Based on a comparison between efforts required for separating these two groups and the benefits of one-stop security, and considerning the complexity required for the separation, some airports where there are not many transfer passengers may decide that the system is not beneficial enough for them. These airports do not adopt the system even if the equivalence of the standards has been mutally recognized by the two states. I think their decision is wrong because one-stop security has high potential value. If more aiports around the world implement one-stop security and exempt transfer passengers from transfer security screening, the benefits for passengers would be immeasurable. National governments therefore should more actively cooperate with other states/regions to promote equivalence verification of their security standards. Airport operators should give priority to passengers' convenience instead of convenience for their airports. While one-stop security may not be very beneficial to airports with a small number of transfer passengers, they should correctly appreciate its potential value. If every airport takes a step forward, however small it may be, I'm sure it will produce large benefits.

4. Off-airport handling

Off-airport handling comprises handling processes performed outside of an airport instead of within an airport. You usually check in your hold baggage at the airport check-in counter. If your baggage is picked up at a place convenient to you, such as at home, a hotel, or a railway station, and delivered to the airport, handling of baggage at the check-in counter will be unnecessary. If combined with Web check-in, you can directly go to the security checkpoint without visiting the check-in counter. Some Japanese airlines already provide this service. They pick up your baggage at your home, company, or other designated place and deliver it directly to your destination airport overseas.[13] In terms of Smart Security, however, it is not sufficient that baggage is picked up outside of an airport. It is important to increase the flexibility of

12 https://www.aviationwire.jp/archives/169523

13 https://www.jal.co.jp/inter/baggage/empty/

security screening and improve efficiency in security screening by screening picked-up baggage at off-peak times at airports or at remote facilities, which is called “off-airport screening.”

If off-airport handling is widely adopted and the number of bags that will be picked up outside of airports increases, how to screen them effectively can become a challenge. I think a key in considering how to address this challenge lies in the Regulated Agent(RA) Regime of a secure supply chain of air cargo. The RA regime allows the Regulated Agents to conduct security screening of air cargo. If this regime is applied, it would be possible for passengers’ bags picked up off-airport to be screened by a RA before being loaded on airplanes. Particularly in Japan, major freight forwarders are qualified as RAs. I think it is possible to use these freight forwarders to establish an RA Regime system for passengers’ baggage. If we adopt a risk-based security approach here, it may be possible to establish a system where baggage of trusted passengers can be screened by an RA and that of unknown passengers is required to undergo full security screening at airports.

Another proposal of mine is the use of explosive detection dogs (EDDs). It has already been proven that EDDs are effective in detecting explosives. In recent years, they have gradually been used for security screening of air cargo. While it is still necessary to examine whether they can be used as a primary tool for security screening of hold baggage, I think EDDs are effective in improving its efficiency.

5. Closing Remarks

To overcome difficulties faced by aviation security, such as expanding traffic, increasing air passengers, and increasingly elaborate threats, all airports must realize Smart Security. All the approaches to realizing Smart Security that are presented in this paper are key factors in present-day aviation security. In closing, I would like to mention three important points to further promote efforts to realize Smart Security. The first point is that the industry should take the initiative in continuing to develop innovation. There are many things that can be solved by technology. It is necessary to continue to seek innovation that is beneficial to aviation security from a long-term perspective. The second is that states and international organizations should continue their efforts to modernize the existing regulations in order to support the realization of Smart Security. It should be avoided that effective options are inhibited by obsolete regulations. The third and most important point is that states, international organizations, relevant organizations, and stakeholders in industires should cooperate with each other to make concerted efforts. As described above, many entities are involved in one approach. Therefore, without cooperation, it would be impossible to achieve Smart Security. I hope that relevant entities around the world will make concerted efforts to realize Smart Security.