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AGENDA ITEM 4: AIR NAVIGATION

LEVERAGING DIGITALIZATION AND AUTOMATION FOR SMART AIR NAVIGATION AND AIRPORT OPERATIONS

(Presented by Hong Kong, China)

SUMMARY

The Hong Kong International Airport (HKIA) has been the world's busiest cargo airport since its opening in 1998 and developed into an international aviation hub. To propel the HKIA towards a Smart Airport City, a number of smart digitalization and automation initiatives are implemented through collaboration among the air navigation service provider, airport operator and regulator, with a view to further enhancing safety and efficiency in air navigation and airport operations.

This paper shares the experience of Hong Kong, China in successfully implementing two pioneering initiatives through such collaboration, namely (a) Digital Apron and Tower Management System and (b) the use of autonomous vehicles at the HKIA, and encourages States / Administrations to consider benefits in collaboration for deployment of digitalization and automation for smart air navigation and airport operations; and share their relevant experience. The paper also calls for development of guidance materials and standards to ensure a harmonized approach for expediting deployment of autonomous vehicles at airports.

LEVERAGING DIGITALIZATION AND AUTOMATION FOR SMART AIR NAVIGATION AND AIRPORT OPERATIONS

1. INTRODUCTION

1.1 The Hong Kong International Airport (HKIA) was opened in 1998 and has since developed into an international aviation hub and the world's busiest cargo airport. To propel the HKIA towards a Smart Airport City, a digital transformation roadmap has been formulated collaboratively by Hong Kong Civil Aviation Department (HKCAD) and Airport Authority Hong Kong (AAHK), which encompasses a broad scope of digitalization initiatives and business strategies, through the adoption of proven and modern-day innovative technologies to achieve deepened and widened integration of stakeholders in aviation community including air navigation service provider, airport operator, aircraft operators and regulator.

1.2 The Digital Apron and Tower Management System (DATMS) is a collaboration initiated by HKCAD and AAHK to support operations of the HKIA under its Three Runway System (3RS) Expansion Project. The DATMS, one of the largest-scale installations worldwide, makes use of digitalization and artificial intelligence to provide panoramic out-of-window views of the airfield including, runways, taxiways and aprons, which assists air traffic control (ATC) and airport operations in further enhancing safety and efficiency, especially under adverse weather conditions such as low-visibility situations, rainstorm, and night time.

1.3 Furthermore, AAHK has been exploring opportunities for leveraging automation to enhance aviation safety and security by replacing manual processes. One of the new initiatives is to make use of autonomous vehicles technology in airport operations. HKCAD, as the regulator for airport safety and security for the HKIA, has been working closely with AAHK in formulating / defining the project scope, system features and assessment criteria. Regulatory advice was also provided to AAHK throughout the planning, design, implementation, transition and regular reviews for use of autonomous vehicles operating within the HKIA.

1.4 This paper shares experience of Hong Kong, China in adopting a collaborative approach for implementation of DATMS and autonomous vehicles for smart air navigation and airport operations.

2. DISCUSSION

DIGITAL APRON AND TOWER MANAGEMENT SYSTEM (DATMS)

2.1 The DATMS comprises two sub-systems, namely Digital Tower Facilities (DTF by HKCAD – the air navigation service provider) and Digital Apron Management System (DAMS by AAHK – the airport operator) running on respective platforms adopting common system architecture by the same technology solution provider. While the overall contract with the technology solution provider is managed by AAHK, a task force was established consisting of members from HKCAD and AAHK to oversee implementation of DATMS and share technical solutions to issues commonly encountered.

2.2 Through such a collaborative approach, common system architecture, interfaces and technical solutions are developed and implemented for these two sub-systems, where real-time digitalized video data, flight / vehicle information, parking stand information and surveillance data can be shared seamlessly via respective fire-walls, enabling each party to ramp synergies, save cost and reduce implementation time.

2.3 With advancement in digital video technology, physical visual constraints are overcome by supplementing out-of-window views captured by ultra-high resolution cameras. The views are stitched into panoramic views augmented with essential information (*Figure 1*) that

significantly enhance operators' visual capabilities and appreciation of airfield activities. Some of the major operational benefits of DATMS in enhancing situational awareness of operational staff include:

(a) high-definition cameras with low-light sensitivity providing enhanced visibility under low light / visibility conditions such as night time conditions and during adverse weather;

(b) high-definition cameras mounted at strategic locations with optical zoom capabilities providing clear views on blind spots; and

(c) application of smart digital video technology and artificial intelligence generating real-time predictive alerts of conflicting situation in the runway, taxiways and airfield restricted areas.

2.4 Following the successful trials at the HKIA in 2020, the first phase of the DATMS was implemented in accordance with the ICAO Global Air Navigation Plan and relevant guidance documents. The Phase 1 DATMS was successfully commissioned in July 2022. Experiences have confirmed the operational benefits gained. The DATMS has won the 2023 Technology Innovation Awards of the Airports Council International (ACI) recognizing the collaborative efforts of HKCAD and AAHK. The Phase 2 DATMS, which would support the 3RS project, is scheduled for completion by 2024.

AUTONOMOUS VEHICLES APPLICATIONS AT THE HKIA

2.5 With the advancement of autonomous vehicles technology, the HKIA has been progressively adopting autonomous vehicles for airport operations. The HKIA was the first airport to deploy Autonomous Electric Tractors (AETs) into live operations for baggage conveyance in 2019 (*Figure 2*). Autonomous Patrol Cars (APC) for security patrolling along the airport perimeter (*Figure 3*), and AETs for cargo towing (*Figure 4*), were subsequently put into operation in 2021 and 2022 respectively. The HKIA further deployed Autonomous Shuttle Bus (ASB) (*Figure 5*) for airport staff in April 2023.

2.6 Airside is a complex and dynamic environment with various activities, including concurrent aircraft maneuvering, moving vehicles and airport operating personnel performing aircraft handling. With a view to further safeguarding airport safety and security while operationalizing the use of autonomous vehicles for airport operations, HKCAD has been working closely with AAHK throughout different stages of project development so as to ensure that these vehicles could be safely and effectively integrated into airport operations from regulatory perspective. One of which was to jointly formulate the assessment and acceptance criteria, while pending for international standards and guidelines.

2.7 Autonomous vehicles were required to prove their technical capability in terms of road-worthiness, while on the other hand, must be able to demonstrate their specialized / designated capability for serving different operations / tasks. For the purpose of demonstrating the above autonomous vehicles' capabilities, comprehensive test plans to clearly stipulate the jointly agreed test requirements, such as stringent level of system failure or dis-engagement, were prepared and agreed prior to the assessments.

2.8 Apart from performing rigorous factory acceptance tests on the autonomous vehicles' obstacle detection capability as well as positioning accuracy and system durability, comprehensive safety risk assessment in accordance with the ICAO and local safety management requirements was conducted to identify and evaluate potential hazards associated with the proposed use of autonomous vehicles at the HKIA. Operational procedures covering all aspects of vehicle operations, maintenance, training, emergency response and occurrence investigation were produced and thoroughly reviewed.

2.9 To validate the reliability and performance of the autonomous vehicles under a real operational environment, thorough on-site trials were performed under tactfully selected and different real life scenarios. These include docking accurately; maneuvering in merging traffic appropriately;

maneuvering precisely along the geo-fenced vehicular lane and demonstrating correct reaction with obstacles, etc. Moreover, such trials were conducted under various weather conditions, day and night time, traffic scenarios and other operational environments.

2.10 For transitioning from the trial to the operational phase, change management activities for engaging stakeholders, including operating procedures dissemination, airport community briefings / meetings, information promulgation by means of circulars or other means, had been conducted so that all stakeholders at the HKIA were fully aware of the introduction of autonomous vehicles for the particular application. To avoid ambiguity, airside driving regulation was also reviewed and updated to clearly stipulate that the autonomous vehicles have the right of way, and vehicles other than emergency and recovery vehicles are required to give way to autonomous vehicles. Enforcement actions related to "not-giving way to autonomous vehicles" were also strengthened with a view to promoting safety awareness of airside drivers.

2.11 Operations at the airports have long been dependent on manpower resources for certain driving tasks. Leveraging the use of autonomous vehicles in airport operations not only relieves airport operators from such dependency in the long run, but also provides a more safe and efficient service by operating around-the-clock, especially under adverse weather conditions. Adopting a rigorous and evidence-based approach is important to ensure the technical viability, operational viability / applicability and safety of autonomous vehicles before their successful deployment at the airport.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

a) note the collaborative efforts among the air navigation service provider, airport operator and regulator of Hong Kong, China in leveraging digitalization and automation for further enhancing safety and efficiency through application of Digital Tower and Digital Apron technologies as well as autonomous vehicles in the HKIA;

b) request the ICAO to collaborate with the industry to develop guidance materials and standards to ensure a harmonized approach for expediting wider deployment of autonomous vehicles at airports; and

c) encourage States / Administrations to consider operational benefits in the collaboration among the air navigation service provider, airport operator and regulator for smart air navigation and airport operations; and share their relevant experience.

— END —

Appendix

Figure 1: DTF showing aircraft taxiing/take-off/landing on South Runway of the HKIA

Figure 2: AET for baggage conveyance

Figure 3: APC for security patrolling

Figure 4: AET for cargo towing

Figure 5: ASB