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COMMITTEE A

Agenda Item 5: Emerging issues
5.5: Other emerging issues impacting the global air navigation system including unmanned aircraft systems (drones), and supersonic and commercial space operations

POTENTIAL OF ARTIFICIAL INTELLIGENCE (AI) IN AIR TRAFFIC MANAGEMENT (ATM)

(Presented by Singapore)

EXECUTIVE SUMMARY

This paper highlights the potential of digital technologies such as Artificial Intelligence (AI) to accelerate achieving the air traffic management (ATM) enhancement goals of the Global Air Navigation Plan (GANP). This can be realised through the purposeful engagement of research, academia, industry and other stakeholders including regulators to facilitate a globally coordinated approach as aviation, and ATM in particular, proceeds with further digitalisation.

Action: The Conference is invited to:
a) recognise the potential that digital technologies, such as AI, have for aviation and discuss possible applications to ATM;
b) request ICAO and States to closely monitor research developments in aviation and, when necessary, engage their respective regulatory mechanisms to ensure that the necessary policies and regulations are in place; and
c) request ICAO to consider establishing a means to facilitate the sharing of information and research by the aviation community.

1. INTRODUCTION

1.1 The *Global Air Navigation Plan* (GANP, Doc 9750) is ICAO's strategic document for air navigation. It presents a comprehensive planning tool supporting a harmonised global air navigation system by identifying potential performance improvements available today, detailing the next generation of ground and avionics technologies that will be deployed worldwide, and provides the investment certainty needed for States and industry to make strategic decisions for their planning purposes.

1.2 The 39th Session of the ICAO Assembly endorsed the fifth edition of the GANP which was updated with the aviation system block upgrades (ASBUs) framework that clearly articulates step improvements and necessary procedures, systems, training, and regulatory approvals in each module. In

addition, the GANP also includes current activity related to demonstrations and early implementation activities and further lists the appropriate reference documents. This promotes awareness among stakeholders, such as standards making organisations (SMOs) and regulatory bodies, and facilitates timely provisions for future operations.

1.3 In further support of the GANP and to increase global awareness of industry developments within the community, ICAO hosted the second Global Air Navigation Industry Symposium (GANIS/2) from 11 to 13 December 2017 in Montréal, Canada. The symposium spanned a wide array of topics on innovation and future system capabilities that provided an industry-wide snapshot of developments and insights as to how stakeholders could collaborate to address technical, operational, regulatory, and economic challenges.

1.4 The growing pace of digital technological advancement provides opportunity to advance the global aviation industry, but is also a challenge that can disrupt the aviation industry. This paper identifies one such other area in Artificial Intelligence (AI) and recognises that there is value in early engagement of research partners that provides targeted focus to develop a globally-coordinated approach to its application in ATM.

2. DISCUSSION

2.1 Artificial Intelligence in ATM

2.1.1 The differentiating factor of an AI system from a standard software system is the characteristic ability to learn, improve, and predict. Through training, an AI system is able to generate knowledge and apply it to novel situations not encountered before. While computing powers were a barrier to adoption previously, advancements and greater availability of data has propelled AI applications across industries. Today, AI capabilities are proliferating across the transport sector through AI-enabled autonomous vehicles. Faced with the challenges of growing traffic, resource demands, increasing uncertainties, and operational complexity, ATM can exploit the power of AI to empower current operators and boost productivity through the capability of decision making under uncertainties and provision of optimised situational strategies that procedures or simple algorithms cannot provide. This would assist operations in managing varied air traffic scenarios with high efficiency and safety.

2.1.2 Singapore has initiated work to develop AI-based applications for ATM. The ATM Research Institute (ATMRI) under the auspices of the Centre of Excellence for ATM is performing research to develop an Air Traffic Control Officer (ATCO) decision-making tool that leverages AI, to learn and subsequently predict traffic management strategies of planning controllers for en-route operations. When matured, the tool will provide advisories to ATCOs that better organise air traffic flows and reduce the tactical flight interventions needed from executive surveillance controllers, while allowing planning controller to focus on strategic-level planning.

2.1.3 The developed Machine Learning based AI agent can learn ATCO traffic management strategies from automatic dependent surveillance-broadcast (ADS-B) data alone. It deconstructs and identifies various traffic patterns and associated air traffic control (ATC) actions and strategies. It then generalises and learns such patterns that when subsequently applied to an operational scenario in ATC, the algorithm can generate a host of possible ATCO actions for a flight entering the sector, and can select the most probable and desired flight path based on the aircraft's trajectory information at a sector entry point. Results of the research has been promising - through learning and validation based on one month of ADS-B data, the AI agent is able to predict ATCO actions, for complex traffic scenarios, at an accuracy

of above 70%. It is expected that the model will improve significantly with more and varied data samples, as well as the inclusion of wind and weather data.

2.2 Potential Benefits of Artificial Intelligence

2.2.1 The present day air traffic system is reaching its operational limits and accommodating future air traffic growth will be a challenging task for air navigation service providers (ANSPs). There is a clear need to substantially increase the existing capacity of airspaces without significantly increasing the demand on the limited human resource and cognitive capabilities of ATCs. New paradigms with AI may increase anticipatory and decision making capabilities within complex and uncertain environments. AI systems have high potential in ATM, specifically in areas which involves decision making under uncertainty (e.g. conflict detection and resolution) and prediction with limited information (e.g. trajectory prediction). These approaches can support the human operators in exploitation of timely and dynamic information on atmospheric hazards, traffic fluctuations, and airspace utilisation.

2.2.2 In addition to developing solutions to support en-route operations, AI can be applied in: i) speech recognition to act as an additional safety net to detect read-back errors; ii) trajectory synchronisation of aircraft ground movements that provide optimised taxiing strategies that comprehensively accounts for arrivals and departures as well; and iii) predicting the most optimal runway configuration for a given arrival sequence and departure schedule so as to maximise the runway throughput. With the development of these tools, it is envisioned that AI will be integral to ATM operations in the future to form a highly automated environment capable of supporting high intensity and more complex operations. In similar fashion, these decision-making tools also have the potential to ensure that aviation is not held back by human resource constraints.

2.3 Preparing for AI-enabled ATM

2.3.1 Notwithstanding its potential, embracing AI-enabled ATM is not straightforward. A possible challenge of adoption is the lack of relevant competencies to understand AI in aviation. For service providers and industry, awareness of their capabilities can help align AI applications to intended functions. For regulators, this would facilitate the standardisation and certification process. As AI technologies continue to progress quickly, the global aviation community would benefit from a firm view of developments within and beyond the industry, to understand its impact to ATM and decipher how technology planning and regulation will be affected.

2.4 There is therefore a need to align research, industry, State regulators and service providers to ensure readiness to face and manage an environment where ATM is supported by highly intelligent automation functions that process and generate advisories in a constantly evolving manner that can even adapt to new airspace users such as unmanned aircraft systems (UAS).

2.5 In Singapore, the Centre of Excellence for ATM has drawn together ATM researchers, academia, industry, and other stakeholders for the purpose of developing and delivering future ATM solutions while maintaining interoperability between States and regions. This function can be replicated at a global level to keep pace with other industries that are leveraging on technological advancements enabled through the fourth Industrial Revolution. As the promise of intelligent automation can only be realised through a globally coordinated approach various possibilities could be considered in future to facilitate discussion. Drawing reference from the ICAO Drone Enable symposiums, one initial option could be to extend participation at the Global Air Navigation Industry Symposium towards research institutes and technological disruptors in other industries.

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