THE LEADING JOURNAL IN GLOBAL CNS/ATM COVERAGE

Air Traffic Safety ELECTRONICS INTERNATIONAL

July/September 2024, Vol. 2, No. 3

https://dextermarie.com/atsei-journal/

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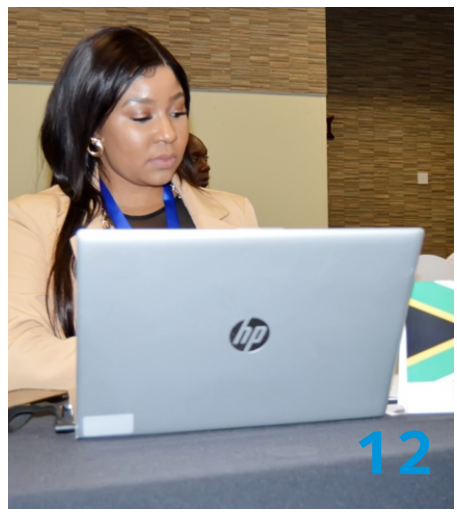

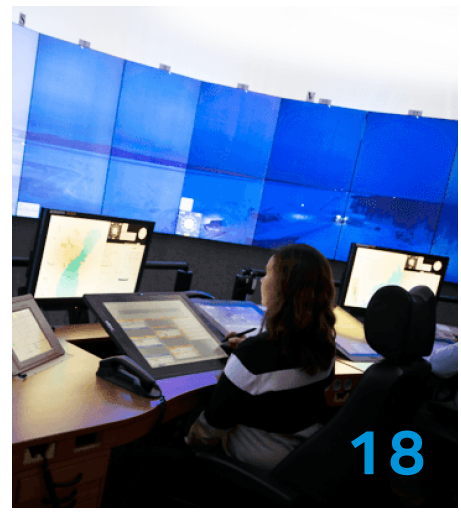

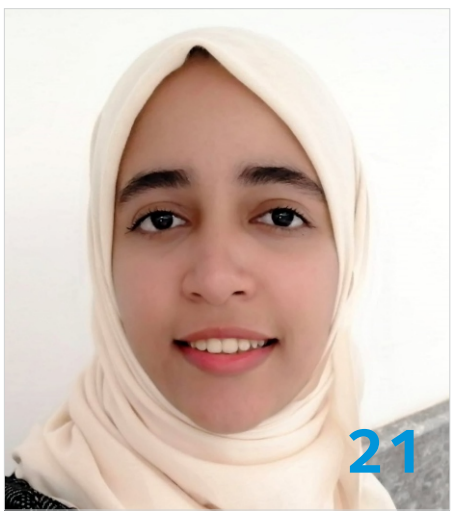

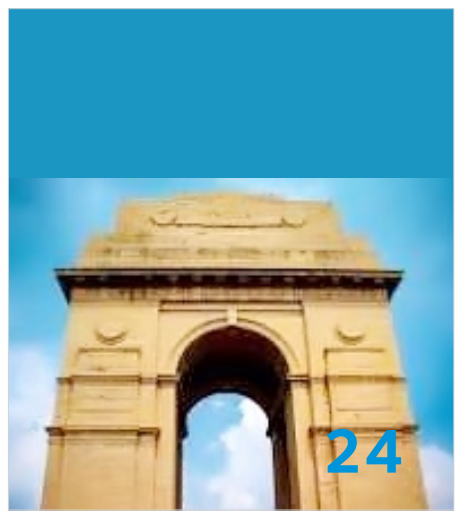

Air Traffic Safety Electronics International (ISSN 1115-2109) is published quarterly for a worldwide circulation by DexterMarie Company Limited P.O. Box 17336, Ikeja GPO 100001, Lagos State, Nigeria. All correspondence should be directed to: P.O. Box 17336, Ikeja GPO 100001, Lagos State, Nigeria; Tel: +2348156705036/ +2348067461324; +2348156705036 (WhatsApp); E-mail: atsei@dextermarie.com. Subscription is free to qualified senior officials, executives and other qualified stakeholders directly involved in the CNS/ATM, air navigation and air transport industries. All other subscriptions attract annual subscriptions of ₦9,000 (Nigeria), $37 (West/Central Africa), $39 (East Africa), $41 (Southern Africa), $41 (North Africa), and $49 (Rest of the World). All subscriptions are treated as bundle subscriptions, incorporating both the print and digital versions of the journal except where a subscription request is for either the print or the digital version. For detailed subscription information, please visit: **https://dextermarie.com/atsei-subscription/**. The publisher makes no warranty, either implied or express, as to the accuracy or nature of the content of this journal. No part of this publication may be reproduced in any form or by any means without the prior written permission of the publisher.

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Editorial

AVIATION: PUSHING BOUNDARIES WITH INNOVATION AND TECHNOLOGY

In no segment of the global industrial ecosystem has there been – perhaps, since the dawn of the 19th century or more appropriately since the free availability of the World Wide Web in the late 1980's – a much livelier exhibition of a closely-knit affinity with the affordances of innovations and technologies than in the aviation industry. Perhaps, it would also not be totally out of place to mention three other siblings of aviation – aerospace, aeronautics, and space.

Innovations in the realms of digitalisation, automation, virtualisation, and even cloud computing technologies are unleashing a barrage of technological affordances that are proving too tempting for aviation and aerospace alike. Take, for example, the Ethernet-based Time-Sensitive Networking (TSN) technology, which is the subject matter of this edition's *Technology Matters*. The seminal technology targets the development of real-time Ethernet solutions and standards that would provide the level of reliability, predictability and time synchronisation required for real-time deterministic applications. It is a technology that is based on open standard interfaces and is also an Open Systems Interconnection (OSI) Model Layer 2 – Data Link Layer – technology. Although this technology's traditional application terrains are the transportation, utilities, manufacturing and automotive industrial landscapes, aviation and aerospace are beginning to find increasing use cases for it especially in the realm of airborne Ethernet communications where time-criticality, traffic prioritisation, reliability and predictability are crucial performance factors.

There is no gainsaying the fact that the growing flirtation of the global aviation industry with innovations and technologies has actually been helping the industry to navigate the labyrinthine corridors of knotty challenges that threaten the regularity, efficiency, security, safety, and sustainability of international aviation operations. Satellite technologies, for example, have been used to provide aviation with cutting-edge solutions in communication, navigation, and surveillance (CNS). Over a couple of years ago, the Spanish air navigation service provider, ENAIRE, and leading ATM systems development company, Indra, announced a joint venture, Startical, for the development of a satellite-enabled air traffic management solution. The project is a satellite surveillance and VHF communication initiative that will deploy a constellation of over 200 small low-earth-orbit satellites that will enable surveillance and VHF communication services to be provided especially in remote and oceanic regions. This initiative is particularly innovative in the sense that it is allowing for a seamless mix of both space-based and VHF-based technologies for the provision of an innovative mix of communication and surveillance services.

On regional and national levels, industry stakeholders are leveraging technologies to shun out out-of-the-box initiatives designed not only to modernise the techno-operational space but also to provide the levels of interoperability and harmonisation that modern-day technology-savvy aviation thrives on. We can mention the United States of America's NextGen (Next Generation Air Transportation System) initiative, India's GAGAN (GPS Aided Geo Augmented Navigation) system, and Europe's Single European Sky ATM Research (SESAR). There are also the global air traffic management initiative, SWIM (System Wide Information Management), Japan's CARATS (Collaborative Actions for Renovation of Air Traffic Systems), and China's CNAS (China New Generation ATM System).

Talking about the challenges currently facing the air navigation service provision sector particularly in relation to the increasing growth in air traffic volumes, one technology that is showing the potential of pushing the boundaries of air traffic management is the rapidly evolving digital remote tower (DRT) technology. This technology is all about providing air traffic control and allied services to one or more geographically dispersed airports or aerodromes from a central and equally remotely located remote tower centre.

To say that this is an upbeat development will be an understatement in an industry sector where the overarching concerns have always centred on the provision of air traffic services in a manner that factors in air navigation service providers' bottom line vis-à-vis operational efficiency and safety. The bourgeoning RDT market profile also serves as a veritable testimony and as Michael Ellinger, Strategic Product Manager, ATM Tower for Frequentis, has further testified in this edition's cover story on RDT: "The market has moved beyond early adopters, and the technology is now widely used by customers in Europe, Australia, and North America." ■

Adeyinka Olumuyiwa Osunwusi, PhD.

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Air Traffic Safety ELECTRONICS INTERNATIONAL

JULY-SEPTEMBER 2024, VOLUME 2, NUMBER 3

AIR TRAFFIC SAFETY ELECTRONICS INTERNATIONAL is published by:

DexterMarie Company Limited
P.O.Box 17336, Ikeja GPO 100001, Lagos State, Nigeria
Phone: +2348156705036
E-mail: info@dextermarie.com
Website: https://dextermarie.com

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REVOLUTIONIZING THE ASIA PACIFIC AIR TRAFFIC SAFETY ELECTRONICS LANDSCAPE: SENTHILVEL BALASUBRAMANIAN, IFATSEA ASIA PACIFIC REGIONAL DIRECTOR

When the whole issue for discussion comes down to the waves of dynamic changes swirling around the global aviation landscape – from the increasing adoption of space-based ADS-B and the steady shifts towards RDT technologies to the imminent incursion of artificial intelligence technologies and the feverish moves towards the Free Route Airspace concept – the Asia Pacific (APAC) region is definitely aligned with the global trends, so says Senthilvel Balasubramanian.

A highly experienced and widely trained Indian air traffic safety electronics professional who is famed for having championed the introduction of the ATSEP Human Factors agenda to the ICAO Asia Pacific (ICAO APAC) CNS/SG, Senthilvel Balasubramanian is the Asia Pacific Regional Director for the International Federation of Air Traffic Safety Electronics Associations (IFATSEA). He is also a member of the IFATSEA Executive Board. In a recent interview with *Air Traffic Safety Electronics International* Managing Editor, Adeyinka Olumuyiwa Osunwusi, PhD, Senthilvel shared his insights regarding a wide array of industry subject matters from the changing climates of aviation operations consequent upon technological evolutions to the activities of the Asia Pacific region of IFATSEA.

As the Regional Director of the Asia-Pacific region of the International Federation of Air Traffic Safety Electronics Associations (IFATSEA), what are some of the dynamic changes you are seeing today across the Asia-Pacific aviation landscapes in terms of air navigation services provision and airports operation?

From the ANSP point of view, the dynamic changes I see include the adoption and implementation of space-based ADS-B as well as the increasing deployment of remote and digital tower technologies. Countries are pioneering the use of Artificial Intelligence (AI) in air traffic management automation systems that can predict congestion and reroute traffic in real-time to optimize airspace usage. The region is also progressively transitioning to Performance-Based Navigation (PBN) and the concept of Free Route Airspace (FRA).

When we look at airport operations, I can list a few points. With the rapid growth in passenger numbers, many airports in the Asia-Pacific region are undergoing significant expansion projects to increase capacity. These include building new terminals, expanding existing ones, and constructing additional runways. Airport expansion projects are increasingly incorporating sustainable practices, such as green building standards, energy-efficient designs, and measures to minimize environmental impact. There is also the transition to electric ground support equipment (GSE) and vehicles to reduce emissions from airport operations. Implementation of facial recognition technology for seamless passenger identification at check-in, security checkpoints, and boarding gates also constitute another change aspects. One can also mention the deployment of automated self-service bag drop systems to streamline the baggage check-in process. Another area of change involves the integration of Internet of Things or IoT devices throughout the airport to have smart lighting and remote monitoring and management of different systems.

And how would you compare these changes with recent and current scenarios in the global aviation ecosystem as a whole?

The Asia-Pacific (APAC) region is closely aligned with global trends. I see lots of inspiration and takeaways from NextGen and SESAR in terms of revolutionizing air traffic management with advanced technologies, enhancing efficiency and safety. Whether AI or remote tower technologies, they are catching up all over the world globally though they are initiated mostly in Europe or in the USA. One good example I can refer to is ASEAN Single Aviation Market, which is an APAC effort like the European Union's Single European Sky initiative with both aiming to harmonize regulations and liberalize the airspace.

Similarly, the PBN and FRA concepts are being adopted in APAC as well with a global push towards creating seamless airspace across borders. The use of smart technologies, such as automated baggage handling and biometric screening, is becoming a widespread feature of the global ecosystem. The growth of low-cost carriers (LCCs) in the APAC is very much comparable with the growth of LCCs in Europe and the United States.

In terms of infrastructure, regulations and operations, which Asia-Pacific country or countries would you describe as the centre or centres of action regarding the changes you have highlighted?

In the Asia-Pacific region, several countries stand out as centers of action in terms of infrastructure, regulations, and operations, reflecting significant advancements and leadership in the aviation sector. China, Singapore, Australia, Japan and India can be highlighted in some key areas. China leads in large-scale infrastructure projects. Singapore excels in smart airport initiatives. Australia leads in remote tower technology. Japan leads in advanced airport operations, while India is focusing on airport development for the purpose of accommodating the growth of regional connectivity with low-cost carriers.

How would you describe the status of India today in terms of the techno-operational aspects of CNS/ATM operations as well as with respect to issues revolving around operational safety, security and efficiency?

The growth in air traffic, driven by economic development and the rise of low-cost carriers (LCCs), has led to increased demand for efficient air traffic management. India is working on enhancing its airspace capacity through modernization and expansion projects. India is actively modernizing its CNS/ATM systems, focusing on advanced technologies to improve airspace management and operational efficiency. The country is investing in surveillance systems, satellite-based navigation, and communication infrastructure to enhance airspace management and improve efficiency.

India is investing in the training and certification or licensing of air traffic controllers, and ATSEP to ensure high safety standards. India has also successfully developed specialized maintenance units across the country for module and component level servicing of CNS equipment to ensure operational- and cost-efficiency. Enhanced security measures are in place at Indian airports, including advanced screening technologies, biometric systems, and strict access controls. India is also working on improving cybersecurity measures to protect aviation infrastructure from cyber threats.

GAGAN (GPS Aided Geo Augmented Navigation) system, developed by India, is a regional satellite-based augmentation system that enhances the accuracy and reliability of GPS navigation for aviation in the region. India's Regional Connectivity Scheme (UDAN) aims to enhance regional connectivity by

making air travel more affordable and accessible, thus contributing to overall operational efficiency.

The country has made significant strides in enhancing safety and security, though challenges remain, particularly in managing high air traffic volumes and evolving security threats. India is working to improve operational efficiency through infrastructure development, integration of systems, and regulatory improvements.

And what about issues revolving around Indian ATSEP's competence, training and certification or licensing?

As technology evolves, ATSEP must continually update their skills to handle new systems and technologies, which can be challenging given the rapid pace of advancements in aviation technology. Though this remains challenging, Indian ATSEP are generally well-trained and made competent, with a focus on maintaining high standards in operating and maintaining CNS/ATM automation systems.

India has a huge potential of young ATSEP who are trained as per ICAO DOC 10057 right from the initial, basic phase to the continuing professional development phase. The Indian specialized maintenance units (SMU) are manned by highly technical and competent ATSEP to service un-serviceable modules of different makes and models of CNS systems. A very well-structured training infrastructure is also available across the country for training ATSEP and certifying their proficiency.

As of now, the ANSP trains and certifies ATSEP proficiency. I hope that in future licensing will be done by the regulators. At the same time, I must recognize the challenge in licensing all ATSEP by the regulator in different makes and models of CNS equipment across the big nation.

Talking about ATSEPs in the Asia-Pacific region and the world over, how significant are human factor issues to the tasks and responsibilities of this critical air navigation services workforce?

Unless you understand and appreciate the importance of your own health, doctors and hospitals or the medical systems can't help in improving your health. When it comes to human factors, ATSEP themselves need to be aware of the significance in the first place and make use of the regional guidance material adopted by ICAO APAC.

While answering previous questions, I have highlighted how the entire global aviation has already become technology centric. The safety chain warriors in the end are ATSEP, through whom these technologies are being implemented, operated and maintained. So, their safety job performance is essential. This was rightly pointed out by IFATSEA-APAC and ICAO APAC have already adopted the guidance material prepared by APAC WG under the chair of IFATSEA-APAC. Now, it is up to the ANSPs and affiliates to make use of it for their mutual benefits.

Ignorance of human factor issues pertaining to ATSEP are well visible through several outages, diversion and closure of operations across the globe. This causes huge financial and reputation losses to the ANSP and to the State. Before it leads to a series of major accidents, IFATSEA needs to promote the importance at various levels through appropriate bodies.

I would suggest you go through the APAC Regional Guidance material on human factors of ATSEP to get the detailed picture.

A couple of years or so ago, you undertook and spearheaded an initiative aimed at obtaining and analyzing data regarding the human factor aspects of air traffic safety electronics practices. What exactly motivated this and how would you describe the deliverables today?

Behind the screen, I was also instrumental in bringing this agenda to the ICAO APAC CNS/SG meeting. Once I got an opportunity to lead IFATSEA-APAC, then I prepared a four-year roadmap so that the opportunity is well utilized.

Globally, ATSEP do have a lot of grievances, and they aspire to get included in Annex -1. But as I explained in the previous question, I did recognize the importance of human factors and decided to go forward. As per my conviction, human factors issues are more important, and they resolve most of the grievances in front of ATSEP. I see everything is possible but after promotion of human factors across all regions.

The main ultimate deliverable out of five years hard work is the APAC Regional Guidance Material on Human Factors of ATSEP, right from people resourcing this guidance material covering the entire aspects of human factors. In addition, all the working papers, presentations, research works, data analysis, list of factors and so on, are also deliverables made at different occasions during this period.

In addition, newsletters, webinar outcomes, mastermind presentations are also deliverables that enhanced the key deliverables at the ICAO APAC level.

Sometime last year, the 27th Meeting of the Communications, Navigation and Surveillance Sub-Group of the Asia-Pacific Air Navigation Planning and Implementation Regional Group adoption a number of conclusions and decisions, the most significant of which was Conclusion CNS SG/27/13 relating to the Regional Guidance Document for Addressing Human Factor Issues of ATSEP. How significant is this to you and did the IFATSEA Asia-Pacific Regional Office make any interventions in this direction?

Achieving the desired result means a lot when you do hard work, and you aim at first of a kind. Five years of hard work, covering 2019 to 2023, incorporating my own website for the research, YouTube Channel, newsletters, webinars, research data analysis, five working papers, initial research report to ICAO APAC, concise research report for top management, weekend meetings with mastermind team, and monthly meetings with APAC WG. I spent huge amounts of time apart from money; thanks to my family for their support and understanding.

But, throughout this journey four of

my junior colleagues from India stood with me so consistently. Also, in the mastermind team some of the members did deliver whatever they have committed without any excuses. I treat their gestures as a reward for my hard work, and the adoption of the work through Conclusion CNS SG/27/13 as a reward for them.

At present, I am not very keen on referring to this achievement but to promote it in other regions and at the ICAO Assembly level. But, I would like to mention that when I went for the CNS SG 23 in 2019, I had to explain and introduce IFATSEA at ICAO APAC, but at CNS SG 27 in 2023, the meeting not only adopted IFATSEA work but also started assigning tasks to IFATSEA like other international organizations. It matters a lot to IFATSEA-APAC and I feel proud of this significant transformation of the SG and ICAO APAC office support towards IFATSEA-APAC.

Issues surrounding the integration of Remote Digital Tower services are gaining traction in aviation circles, particularly in the European continent. How is the Asia-Pacific region embracing this emerging air traffic management technology?

Though some countries are actively testing and deploying remote digital towers in the region, I see some challenges that hamper the momentum among developing nations. Let me give a few examples such as navigating required regulatory and safety standards, ensuring that RDT systems meet the required criteria for operational safety and reliability, ensuring interoperability with the existing high-cost automation systems they already have as well as initial investment cost and most importantly the capability to ensure robust cybersecurity measures. owever, slowly this technology will also be embraced by ANSPs in the region.

From your perspective, what are the probabilities for the significant applicability of digital remote towers in the global CNS/ATM operational environments?

Maybe in 10 to 20 years from now we may see only digital towers globally. The probability is quite high. Technological advancements in

cameras, data transmission and processing technologies, and operational benefits will slowly promote digital towers among developing and smaller ANSPs also in the future.

Every major ANSPs do have roadmaps for the centralization of air traffic control operations and enabling the management of multiple airports from a single location. RDT is one such technology that makes their dream possible. So, RDT will play a major role in the coming years.

Now, let's talk about the increasing cybersecurity concerns within the aviation ecosystem. How significant do you think these concerns are and how vulnerable is the aviation industry?

We have discussed earlier about the global shift towards technology-centric systems. In such an environment, cyber security threats are a more serious threat than nuclear or pandemic threats. When we rely more and more on IT-based systems, the threat increases. Furthermore, when we integrate AI into the systems, the threat increases many folds.

Cyber-attacks can disrupt not only flight operations, leading to delays and cancellations, but can also lead to potential safety risks. Cyberattacks on systems that handle vast amounts of sensitive data, including flight plans and so on, can even lead to accidents. So, cyber security is crucial. In my opinion globally, regulators shall take a call on clearly distinguishing cyber security threat and mitigations of CNS/ATM automation systems through competent ATSEP separately and addressing the rest of cyber security threats through national security regulators separately to handle them effectively.

What exactly is the Indian aviation industry doing to ensure a much more cyber-resilient operational environment?

The Indian aviation industry has been taking significant steps to enhance cybersecurity and ensure a more cyber-resilient operational environment. These efforts encompass regulatory measures, technological advancements, training, and collaboration. The Indian government has established the National Cybersecurity Policy to provide a framework for protecting critical infrastructure, including aviation. This policy outlines the strategies and responsibilities for securing digital assets and data.

"AT PRESENT, I AM NOT VERY KEEN ON REFERRING TO THIS ACHIEVEMENT BUT TO PROMOTE IT IN OTHER REGIONS AND AT THE ICAO ASSEMBLY LEVEL"

The Indian ANSP is investing in modernizing its IT and communication systems to incorporate advanced cybersecurity features. Regular training programs and awareness campaigns are done for aviation personnel, including air traffic controllers, IT staff, ATSEP, management, and all other stakeholders. Regular security audits and vulnerability assessments are done to identify and address potential weaknesses in systems and processes.

Finally and talking about your role as the IFATSEA Regional Director for Asia-Pacific, what could you say are your guiding principles as you continue to pilot the affairs of IFATSEA Asia-Pacific?

I have been trying my best to represent all members equally and to ensure that all members have opportunities to contribute and participate as IFATSEA is a non-political forum. My guiding principles also include ensuring all actions and decisions are made in the best interests of IFATSEA and ATSEP, consistently demonstrating commitment and earning the trust of members as well as working towards greater interest across the Asia-Pacific region, representing the interests and concerns of ATSEP professionals within the region and building strong relationships and fostering collaboration with other regional members. However, I cannot certify on my own. ■

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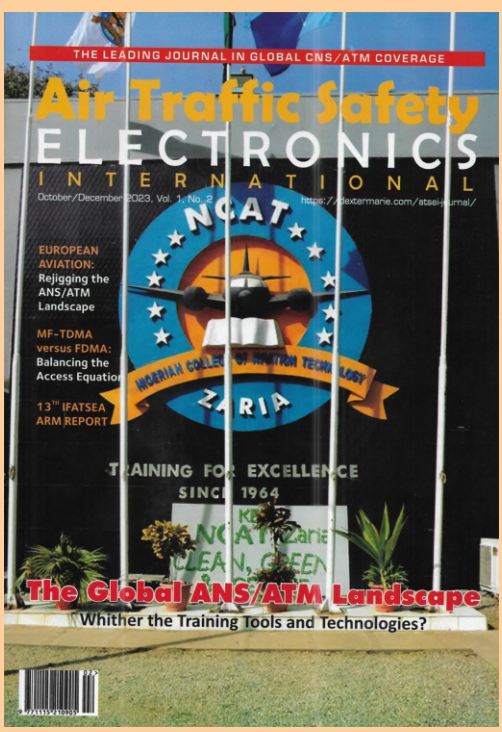
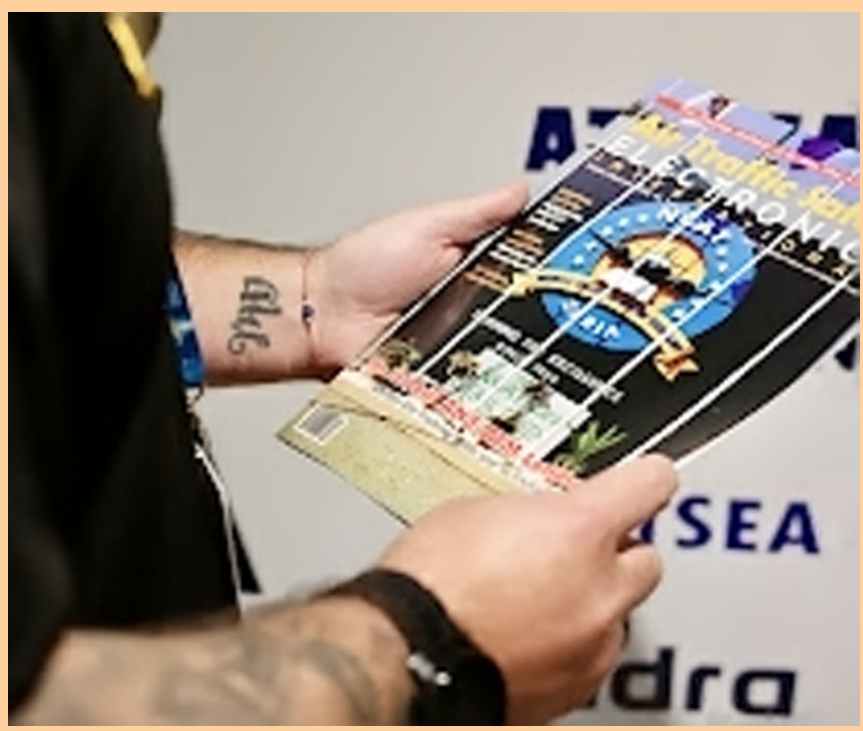




TIME-SENSITIVE NETWORKING: EXPLORING THE POTENTIAL AVIATION AND AEROSPACE USE CASES

By Adeyinka Olumuyiwa Osunwusi, PhD.

InteliSight Electronic Flight Folder EFF. *Photo Credit: Collins Aerospace.*

For the league of industry sectors whose operations revolve around constant and reliable control of physical processes and devices, the efficient delivery of data traffic across network elements is a critical task. For these and quite a good number of other industry players particularly in the utilities and automotive industrial sectors, communication across network devices needs to be carried out in a speedy, timely, predictable, cost-effective, reliable and efficient manner to facilitate high level of Quality of Service (QoS). Traditionally, critical industry players have been having to have recourse to the use of traditional Ethernet, typically based on IEEE 802.1Q and IEEE 802.3 standards, when the game comes down to facilitating cost-effective, reliable and speedy communication across a network.

The rationale behind this choice may not be far-fetched after all. Standard Ethernet is known to be a technology that combines affordability, speed and versatility with high throughput. It is also a robust technology in terms of flexibility and the capability to deliver increased data. In addition, Ethernet typically features non-centralized network with open and widely supported protocols.

Notwithstanding these advantages and the ambitious evolution of Ethernet standards over the years, traffic flows across traditional Ethernet networks are known to be susceptible to latency and jitter whilst guaranteeing just the *best effort* behavior of the networks. There are also challenges revolving around safety requirements, bandwidth reservation limitations, packet buffering and the incompatibility of available network solutions. More importantly, traditional Ethernet lacks **determinism** – a critical performance factor for real-time applications in industrial sectors such as the aerospace, transportation, utilities, manufacturing and automotive industries – where time synchronization and robust controls of traffic flows across network elements are a critical performance factor. This critical performance factor, to be sure, is what has been driving the increasing shifts towards Time-Sensitive Networking (TSN) technology.

TSN is clearly becoming the technology of choice when the needs are all about providing the determinism, scalability and reliability required for the provision of time- and safety-critical communication between bridges or switches and end devices (sender and receiver(s)) in standard Ethernet networks. As a matter of fact, the central objective of TSN is to add Layer 2 deterministic capability to Ethernet-based networks such that data traffic can be delivered much more efficiently from one point to another in a deterministic manner with all network elements sharing a common concept of time. This underscores the fact that TSN is primarily a time-focused technology, a feature that enables the predictability and efficiency of TSN flows. With its time synchronization and traffic shaping features, TSN defines limits for traffic travel time, prioritizes the delivery of time-critical traffic and provides temporal isolation from non-critical traffic, thus guaranteeing ultra-high reliability, low bounded end-to-end latency, low bounded jitter and minimal or zero congestion loss. As part of the time synchronization mechanism of TSN, the IEEE 1588 standard specifies a set of Precision Time Protocol (PTP) profiles for a specific set of TSN applications, thus ensuring the interoperability of TSN networks and network elements in spite of the multi-vendor product nature of the TSN technical terrains.

In terms of versatility, TSN is also a multi-environment technology given the non-limitation of the payloads of the Ethernet frames (stream) of a TSN flow. This capability enables traffic convergence as multiple traffic – both time sensitive and non- time sensitive data traffic – can share a common network and a common sense of time. Aside from this, TSN-enabled networks are famed for enhanced security as they incorporate a number of security mechanisms such as encryption, authorization, and authentication. Scalability is another unique feature of TSN, enabling the robust optimization of topologies and the non-limitation of TSN applications to a specific transmission rate. Unlike traditional Ethernet,

a TSN communication network necessarily guarantees a real-time behavior, ensuring that time-critical traffic is delivered within the bounds of a specified deadline whilst also managing the delivery of best-effort, non-time critical traffic. Additionally, TSN features, unlike traditional Ethernet, a fully centralized network configuration implementing, among other components, a central network controller (CNC) and a centralized user configuration (CUC) required for real-time deterministic applications. It is a technology that is based on open standard interfaces and is also largely an Ethernet standard as opposed to an Internet Protocol Standard (IPS). In addition, TSN is an Open Systems Interconnection (OSI) Model Layer 2 – Data Link Layer – technology. The implication, therefore, is that TSN flows are effectively limited to data packets encapsulated into frames. Aside from this, implementing time-sensitive networking to share a common concept of time with an accuracy of just a few nanoseconds. It is also the primary enabler of that core performance factor of the TSN technology – **determinism**. This synchronization is the key to ensuring reduced and deterministic latency as well as the timely delivery of critical data traffic.

The Open Systems Interconnection (OSI) 7-Layer Model

LAYER	LAYER DESCRIPTION	INFORMATION FORMAT	SERVICES	FUNCTIONALITIES
7	Application	Message	User services	Network virtual terminal, File transfer, Access management, Mail services, and Directory services.
6	Presentation	Message	Information syntax and semantics	Translation, Encryption, Decryption, and Compression.
5	Session	Message	Sender-Receiver interaction control	Establish, maintain and terminate session, Synchronization, and Dialog controller.
4	Transport	Segment	Delivery services	Process to process delivery, Segmentation, Reassembly, and Service point addressing.
3	Network	Packet	Packet delivery (Source to Destination)	Routing and Logical addressing.
2	**Data Link**	**Frame**	**Frame delivery**	**Framing, Physical addressing, Error control, Flow control, and Access control.**
1	Physical	Bits	Bits movement	Bit synchronization, Bit rate control, Physical topologies, and Transmission mode.

components. A TSN network, though, can also be configured either as a hybrid (centralized/distributed configuration) or a fully distributed network to provide ultra-reliable, time-sensitive and low latency communication over standard Ethernet.

Today, the use of TSN for applications in both wired and wireless communication networks scenarios is being explored by industry stakeholders, although wired networks are much more ideal for supporting real-time applications that guarantee predictability as well as low bounded latency, low bounded jitter and minimal congestion loss. This notwithstanding, standards have been developed to enable reliable wireless TSN, particularly from the vantage point of challenges related to time synchronization performance requirements.

TSN – TECHNICAL DESCRIPTION

Time-sensitive networking (TSN) technology represents not only an enhancement on the IEEE 1588 standards but also a set of standard modifications on the IEEE 802.1Q standards. It is a reflection of the work of the Time-Sensitive Networking (TSN) Task Group of the IEEE 802.1 Working Group[1] established in 2012 for the purpose of developing, among other things, real-time Ethernet solutions and standards that would provide the level of reliability, predictability and time synchronization TSN application does not extend to higher level application functionalities.

Technically speaking, TSN is not based on a single specific standard. Rather, it is a set of IEEE 802.1 standards that define guidelines for facilitating reliable and time-sensitive communication over an Ethernet network using a profiles-based mechanism that defines specific protocols, configurations, and features that are appropriate for particular TSN applications. Typical TSN standards include: IEEE 802.1AS/ASRev (Timing and Synchronization for Time-Sensitive Applications), IEEE 802.1Qbv (Enhancements for Scheduled Traffic), IEEE 802.1Qcc (Stream Reservation Protocol (SRP) Enhancements and Performance Improvements), and IEEE 802.1Qav (Forwarding and Queuing Enhancements for Time-Sensitive Streams).

TSN FEATURES

Given the multi-standard characteristics of TSN applications, typical TSN features are usually partitioned in line with specifications and features that are specific to the set of standards developed for TSN applications. The set of TSN standards address the following four features:

1. **Time Synchronization:** The time synchronization feature of TSN is central to enabling networking elements

TSN accomplishes precise timing synchronization using the IEEE 1588 standard-defined Precision Time Protocol (PTP). The time synchronization mechanism is based on a Master-Slave clock relationship whereby distributed Ethernet frames are used to synchronize the clocks of all network elements – the slave nodes - to a common base sub-microsecond time reference clock domiciled in the master element (also known as grandmaster) of the network. This synchronization process is accomplished with the use of the IEEE standard 1588 PTP profile that meets the requirements of a given TSN application. Typical TSN PTP profiles include IEEE 802.1AS and IEEE 802.1ASRev. The IEEE 802.1ASRev essentially reflects changes in performance characteristics and standard requirements, particularly when transitioning to much more safety-critical and time-sensitive applications where instantaneous responses to time synchronization challenges due to network elements failure are imperative.

2. **Traffic Prioritization:** The traffic prioritization features of TSN provide for the allocation of the necessary bandwidth, allowing for traffic flows on the network while prioritizing time-sensitive traffic flows over less critical

packets and guaranteeing low bounded end-to-end latency with zero congestion loss.

The TSN prioritization capability is accomplished using a set of IEEE 802.1 standards such as IEEE 802.1Qbv (Enhancements for Scheduled Traffic), IEEE 802.1Qav (Forwarding and Queuing Enhancements for Time-Sensitive Streams), IEEE 802.1Qcr (Asynchronous Traffic Shaping) and IEEE 802.1Qch (Cyclic Queuing and Forwarding) to achieve TSN mechanisms such as *traffic shaping* and *traffic scheduling*. IEEE std. 802.1Qbv, which provides specifically for deterministic traffic scheduling, defines *time-aware shapers* (TAS), allowing for the assignment of specific time-defined slots to different traffic flows (streams) on the network with priority assigned to critical traffic flows over the rest of the network traffic. Allied to the traffic shaping features are TSN's *traffic policing* mechanisms using IEEE 802.1Qci (Per-Stream Filtering and Policing), thus ensuring that network elements are sufficiently protected from failures or damage through checks on frame timing and content. The IEEE 802.1Qav standard controls traffic flows and allocates bandwidth, thus guaranteeing reduced latency bounds by allowing for the prioritization of real-time traffic over non-real time best-effort traffic using a Credit-Based Shaper (CBS) mechanism. To further improve network efficiency and minimize latency times and jitter, frame pre-emption enhancement for Ethernet MAC (Medium Access Control) outlined in IEEE 802.1Qbu (Frame Preemption) and IEEE 802.3br (Specification and management Parameters for Interspersing Express Traffic) can also be implemented. The IEEE 802.1Qbu standard's role is very significant when it comes to efficiency optimization as the protocol is responsible for how higher-priority traffic flows can take prominence over lower-priority traffic.

3. **Reliability:** The capability to offer redundancy is central to the ultra-high reliability features of TSN-enabled networks. The necessary redundancy mechanisms are defined around the IEEE 802.1Qca (Path Control and Reservation), and the IEEE 802.1CB (Frame Replication and Elimination for Reliability) standards. The IEEE 802.1Qca protocol provides packet routing functions as well as establishes different paths and allocates resources for sending packets to the receiving network element. The IEEE 802.1CB, which essentially aggregates a number of redundancy frame transmission functions, ensures redundancy by replicating and sending packets belonging to a stream along multiple paths whilst deleting the duplicate packets near or at the point of reception. In this way, packets are delivered efficiently and reliably without any delays or congestion loss. This packet duplication and transmission along multiple paths on the network is crucial to ensuring the eventually delivery of the packet at the point of reception even in the event of the failure of a network element.
4. **Resource Reservation and Management:** The capability to guarantee the optimal utilization and sharing of resources is one of the unique features of TSN-enabled networks. The resource reservation, resource management and robust network configuration features of TSN constitute a crucial element for accomplishing this capability and for achieving deterministic networking as well as guaranteeing ultra-high reliability and low latency. The IEEE 802 standards that are crucial to guaranteeing these TSN features include the IEEE 802.1Qat (Stream Reservation Protocol - SRP), the IEEE 802.1Qcc, the IEEE 802.1Qca, and the IEEE 802.1CS (Link-local Registration Protocol).

The IEEE 802.1Qat protocol paves the way for the allocation and reservation of network resources - such as buffers - between the sender and the receiver(s), thus providing end-to-end Quality of Service (QoS), guaranteeing latency, and achieving the desired bandwidth. The IEEE 802.1Qcc, which is an integration of a wide variety of specifications, defines management interfaces and protocols for central network configuration. It is essentially an amendment of the IEEE 802.1Qat standard, providing crucial SRP enhancements and performance improvements to meet the growing needs of new and emerging time- and safety-critical applications.

The IEEE 802.1Qca, on its part, defines the capabilities for stream reservation, including bandwidth reservation, while the IEEE 802.1CS protocol takes care of resource management tasks with the central objective of developing application protocols that distribute information across a network. Essentially, the 802.1CS standard defines methods and procedures for replicating a large registration database from one end of a link to the other end.

AVIATION AND AEROSPACE USE CASES

The prospect for the applicability of Time-Sensitive Networking in civil aviation, military aviation and the aerospace cum space sectors is becoming brighter and brighter by the day, particularly in areas such as airborne Ethernet communication networks and for related onboard Ethernet network applications regarding avionics systems, sensor systems, passenger aircraft cabin management systems, passenger aircraft flight management/control systems and the electronic flight instrument system (classed under the Aircraft Control networking Domain – ACD), on-board warning and crew alert systems (under ACD), military aircraft mission/flight control systems, aircraft-ground communication systems (under the Airline Information Services networking Domain, and in-flight entertainment and connectivity (IFEC) systems situated in the Passenger Information and Entertainment Services networking Domain (PIESD).

A further boost for this prospect, of course, consists of the security requirements as well as the safety- and time-criticality of operations in the aviation, space and aerospace sectors. For example, the emerging application of TSN technology in airborne flight management system (FMS) comes with stringent requirements regarding the precise synchronization of FMS with GPS time, although proprietary applications do not necessarily specify this requirement. To be sure, the traditional communication protocols hitherto in use in these critical sectors, such as Ethernet-based ARINC-664 and MIL-STD 1553, cannot guarantee the safety, security, reliability and timeliness attributes for which TSN has become known.

Safety and timing considerations are a primary driver of the integration of TSN-enabled Ethernet networks into the aviation and aerospace techno-operational environments. To guarantee the seamless integration of TSN into the aerospace terrain, particularly in the area of on-board Ethernet communication networks, work is already at an advanced stage for the development of an aerospace-specific TSN profile – the IEEE P802.1DP standard[2] - under a cooperative IEEE P802.1DP/SAE AS6675 project involving IEEE 802.1 TSN Task Group, SAE Avionics Networks AS-1 A2, and other aerospace industry stakeholders. The project has progressed from the collection of use cases and the collection/description of requirements phases to the actual TSN profile specification stage. Frontline industry players, such as Germany-based Fraunhofer IPMS, New Jersey USA-headquartered Computer Aided Software Technologies, Inc. (CAST) and GE Aerospace, for example, are also expending tremendous energy to deliver cutting-edge TSN solutions for the aerospace industry.

The IEEE P802.1DP/SAE AS6675 aerospace-specific standard under development is being tailored towards the integration of two TSN profiles based on both synchronous and asynchronous operations with the synchronous operation focusing on the IEEE 802.1AS-2020, which offers support for multiple and redundant clocks. Although, the final goal is to develop a single-specification protocol, the standard will be focused on defining IEEE 802.1 TSN profiles for aerospace onboard IEEE 802.3 Ethernet networks hinged on critical TSN requirements and functionalities such as time synchronization (with IEEE 802.1AS), traffic shaping (with IEEE 802.1Qav/1Qbv), per-stream traffic filtering and policing (with IEEE 802.1Qci), management and configuration (with IEEE 802.1Qcc), and redundancy (with IEEE 802.1CB).

In recent times, there has been a bourgeoning of research aimed at exploring prospective use cases for TSN in aerospace. Steiner et al have explored the use of IEEE 802-enabled TSN networks as cabin backbone bus (CBS) for on-board aircraft communication, leveraging upon IEEE 802 standards such as IEEE 802.1AS, IEEE 802.1Qbv, and IEEE 802.1CB[3]. A seminal document[4] in support of IEEE P802.1DP and SAE AS6675 has also explored the whole spectrum of potential aircraft flight network applications covering small and large civil passenger aircraft, military fixed wing aircraft, and military rotary wings aircraft. From the perspective of the space sector, Fiori et al. also proposed and investigated a lite TSN solution to support

[1]IEEE 802.1 Task Group website: https://1.ieee802.org/tsn/
[2]IEEE 802.1DP https://1.eee802.org/tsn/802.1dp/
[3]W. Steiner, P. Heise, and S. Schneele, "Recent IEEE 802 Developments and their Relevance for the Avionics Industry," in Digital Avionics Systems Conference 2014, 33rd IEEE/AIAA, pp. 2A2-1 (2014).
[4]W. Fischer, J. Gelish, M. Hegarty, A. Jabbar, G. Lawton, B. Nelson, J. Rang, G. Scanlon, L. Santinelli, and J. Zaehring, "Aerospace TSN Use Cases, Traffic Types, and Requirements – Document in support of IEEE 802.1DP and SAE AS6675: TSN Profile for Aerospace", Rev. 0.6 (2021).
[5]T. Fiori, F.G. Lavacca, F. Valente, and V. Eramo, "Proposal and Investigation of a Lite Time Sensitive Networking Solution for the Support of Real Time Services in Space Launcher Networks", Vol.12, 2024, pp 10664-10680. https://doi.org/10.1109/ACCESS.2024.3353466.

OREFILE MTHOMBENI:
CHAMPIONING THE COURSE OF WOMEN IN AVIATION

Amazons in Aviation

Air Traffic Safety ELECTRONICS INTERNATIONAL

Orefile Mthombeni is clearly an amazon of aviation per excellence, having carved out an enviable niche for herself in an industry that is famed as a largely patriarchal entity. *Air Traffic Safety Electronics International* caught up with the South African-born air traffic safety electronics professional recently and here's what she had to say:

You have been engaged in the aviation industry for quite some time now. What are some of the changes you are seeing today regarding gender equality and the engagement of female professionals in aviation across the world?

There has been a significant shift towards greater gender inclusivity within the aviation sector. Historically, women were predominantly associated with roles such as air hostesses, with limited representation in other critical positions such as air traffic controllers, pilots, ATSEPs or engineers. Today, there is a growing recognition of the diverse roles that women play within the aviation industry. However, despite these advancements, considerable work remains to be done to achieve comprehensive gender equality on a global scale.

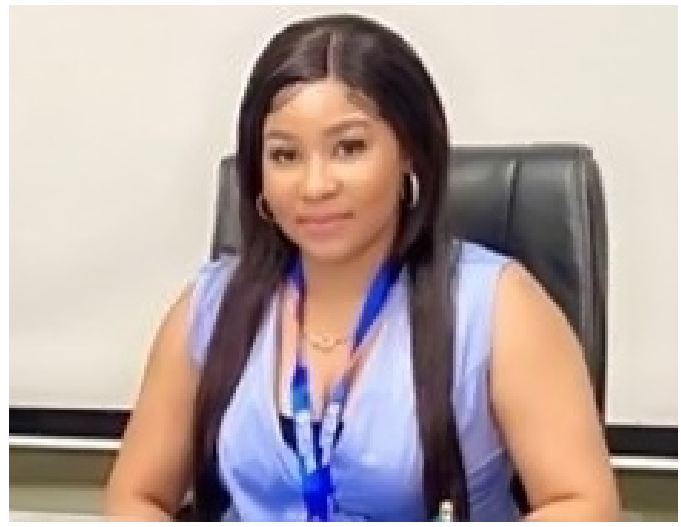
How would you describe the role of women in today's largely patriarchal global aviation landscape?

While progress has been made in overcoming some barriers, significant challenges persist. It is imperative that women are evaluated based on their skills and qualifications rather than their gender. Continued efforts are essential to ensure that women are afforded equal opportunities and are recognized for their professional competencies in a predominantly patriarchal industry.

You are actively involved in the activities of the ATSEP Women wing of the global body, the International Federation of Air Traffic Safety Electronics Associations (IFATSEA). How would you describe the goals, visions, and objectives of the IFATSEA ATSEP Women wing?

The IFATSEA ATSEP Women wing is dedicated to several key objectives. One is the area of Outreach and Engagement where our goal is to connect with female ATSEPs worldwide, encourage their participation in our committee, and share experiences and challenges. We aim to enhance the recruitment and retention of women in ATSEP roles. The other objective is Advocacy. We advocate for issues by engaging with government organizations, private ANSPs, and educational institutions to address topics raised by the committee. Education is another area and here we seek to increase the visibility of ATSEP work outside our organization and provide education to our members about the challenges we face. There is also the aspect of Networking whereby we foster connections among female ATSEPs to build a supportive network. There is also the objective we refer to as Safe Space where we provide a secure environment where female ATSEPs can discuss and address their current challenges.

We have made significant progress toward these goals and have established a global platform for engagement among female ATSEPs. We continue to welcome new members to join our efforts.



And what are your thoughts concerning the level of success recorded by the ATSEP Women wing of IFATSEA so far?

The ATSEP Women wing of IFATSEA has achieved notable success. Our accomplishments include the drafting and review of the Terms of Reference (ToR) at the 2022 and 2023 General Assemblies. We have held quarterly meetings and participated in a joint statement with IFALPA, IFATMA, IFAIMA, and IFISA for International Women's Day. Additionally, our social media campaign for International Women's Day was highly successful. We are committed to continuing this momentum and expanding our impact as more women get involved. Our membership spans a diverse range of countries, including the Netherlands, Argentina, Kenya, Romania, the UK, the USA, Canada, Zambia, Jamaica, Tanzania, Nigeria, South Africa, Albania, France, Mexico, Chile, the Dominican Republic, Peru, and Morocco.

Are any mechanisms currently in place for encouraging female ATSEPs in IFATSEA affiliate countries and associations to replicate and domesticate the activities at the global level?

We are currently in the data-gathering phase, aiming to understand the specific needs, environments, and challenges faced by female ATSEPs in different regions. This information will help us tailor our strategies and encourage the replication and localization of our activities across IFATSEA affiliate countries and associations.

Talking about the global body representing ATSEPs, how would you describe the level of support and commitment of the IFATSEA Executive Board towards the course of ATSEP women the world over?

The IFATSEA Executive Board has demonstrated a strong commitment to advancing the goals of the ATSEP Women wing. They have ensured that we have sufficient time for engagement during the IFATSEA General Assemblies and have provided a platform for regular interaction to address our needs as a sub-committee. Their support is crucial in helping us achieve our objectives and furthering the cause of female ATSEPs worldwide.

What do you see as the most significant challenges confronting female ATSEPs across the world today?

The most significant challenges include issues related to recruitment and retention, persistent bias, and the need for enhanced support. These factors collectively impact the advancement and equitable treatment of women in the field.

And what do you think IFATSEA should be doing at the global level to further advance the course of female ATSEPs?

IFATSEA should continue to support and promote initiatives that encourage the involvement of women in ATSEP roles. Strengthening outreach efforts and ensuring that our initiatives reach female ATSEPs globally are essential to advancing our mission and supporting women in the field.

Looking back, how would you describe your tenure as the Executive President of the South African Air Traffic Safety Electronics Personnel Association (SAATSEPA)?

My tenure as Executive President of SAATSEPA has been an extraordinary experience. I have experienced significant personal growth and observed the association's expansion and increased engagement with affiliates across South Africa. I led the strategic direction and governance of the association, represented our members' interests at both national and international forums, and fostered collaboration and networking among key stakeholders.

Overall, what are your views regarding the future roles of women in aviation's air navigation services realm?

I foresee that women will increasingly assume leadership roles within the aviation air navigation services sector. The ongoing efforts to address gender imbalances and expand opportunities will likely result in greater representation and influence of women in these pivotal roles. ■

Industry Roundup

PEOPLE

BOEING BOARD NAMES NEW PRESIDENT AND CEO

The Board of Directors of Boeing has elected Robert K. "Kelly" Ortberg as the company's new President and Chief Executive Officer, effective August 8, 2024. Ortberg, who will also serve on Boeing's Board of Directors, succeeds Dave Calhoun, who earlier this year announced his intention to retire from the company, having served as President and CEO since January 2020.

"The Board conducted a thorough and extensive search process over the last several months to select the next CEO of Boeing and Kelly has the right skills and experience to lead Boeing in its next chapter," says Steven Mollenkopf, Chair of the Board. "Kelly is an experienced leader who is deeply respected in the aerospace industry, with a well-earned reputation for building strong teams and running complex engineering and manufacturing companies. We look forward to working with him as he leads Boeing through this consequential period it its long history."

"I'm extremely honored and humbled to join this iconic company," says Ortberg. "Boeing has a tremendous and rich history as a leader and pioneer in our industry, and I'm committed to working together with the more than 170,000 dedicated employees of the company to continue that tradition with safety and quality at the forefront. There is much work to be done, and I'm looking forward to getting started."

HENSOLDT EXTENDS CFO'S CONTRACT

The Supervisory Board of HENSOLDT AG has, at its recent meeting, extended the contract of the company's Chief Financial Officer (CFO), Christian Ladurner, by five years. This decision extends Ladurner's contract until the end of July 2029.

"Christian Ladurner has been doing an excellent job for HENSOLDT for years and has played a decisive role in the company's growth in recent years," says Reiner Winkler, Chairman of HENSOLDT's Supervisory Board. "The early extension of his contract gives the finance function the security it needs to continue successfully on its chosen path."

"Following the reorganisation of the Management Board, it is now important to continue the ongoing cooperation," says HENSOLDT CEO, Oliver Dörre. "The finance function has been put on a strong footing by Christian Ladurner over the past two years and has made a significant contribution to the company's impressive growth. I therefore welcome the contract extension and look forward to continuing to work with Christian."

NAV CANADA ANNOUNCES RETIREMENT OF PRESIDENT AND CEO

NAV CANADA has announced the retirement of its President and Chief Executive Officer, Raymond G. Bohn, effective October 31st, 2024. Mr. Bohn has held the position of President and CEO since February 1st, 2021 and has led the company through a period of considerable challenge. He has served NAV CANADA for over 24 years, having joined the company in February 2000.

Prior to assuming the position of President and CEO, Mr. Bohn has served as Vice President and Chief Human Resources Officer, providing leadership and oversight of various business functions including Human Resources, Labour Relations, Corporate Planning and Performance, Operational Training, Stakeholders Relations, and Communications & Public Affairs.

In addition to serving as a NAV CANADA Executive Management Committee member for several years, Raymond Bohn currently serves as a member of the Aireon board. He has also served as a member of the International Civil Aviation Organization's North Atlantic Economic, Financial and Forecast Group among other engagements.

ACQUISITIONS

FREQUENTIS ACQUIRES WORKFLOW MANAGEMENT SPECIALISTS GROISS INFORMATICS

Frequentis, the global supplier of communication and information systems for control centres, has acquired the Klagenfurt Austria-based workflow management systems experts, Groiss Informatics GmbH. The acquisition, which covers all shares in Groiss Informatics as of 1 July 2024, strengthens Frequentis' position in the field of workflow management systems. It also allows Frequentis to further develop its expertise and offer more comprehensive workflow management solutions to its customers across various control centre applications.

"The automation of business processes is a key factor for growth and success in these fast-moving times," says Norbert Haslacher, CEO Frequentis. "With the acquisition of Groiss Informatics GmbH, we are further expanding our expertise and portfolio in the area of workflow management systems and can also support customers in our other business areas in the efficient management of their workflows, especially in control centres. We warmly welcome the Groiss Informatics team to our company."

"I am pleased to be putting our company in good hands after a very long relationship with Frequentis, with this software already being used in some innovative projects," says Herbert Groiss, Co-Founder and Managing Director, Groiss Informatics.

As a long-standing partner of Groiss Informatics, Frequentis already uses the @enterprise product as a component for workflow automation in air traffic control.

Recall that in the third quarter of 2023, Frequentis equally completed the 100% acquisition of GuardREC ATC, the ATC business of the Norwegian company GuardREC, a software company specialising in the development of recorder solutions with data analytics capabilities for air traffic control market.

CONTRACTS

BOEING AWARDED CONTRACT TO ENHANCE KC-46A MISSION CAPABILITY

The U.S. Air Force has awarded Boeing a $16.8 million contract for KC-46A software and data enhancements that will further advance the mission readiness and performance envelope of the world's most advanced multi-mission tanker. The contract includes upgrades to the Onboard Performance Tool software for expedited mission launch, with specific improvements for efficient cargo landing and takeoff and landing data management for flight planning.

"The U.S. Air Force and allies are performing crucial global missions with the growing KC-46A tanker fleet and finding ways to extract more capability from the platform," says Lynn Fox, KC-46 Vice President and Program Manager. "We're collaborating to integrate enhancements like these and bring additional capabilities to the battlespace as rapidly as possible to meet the evolving needs of the mission."

The KC-46A can carry three times more cargo pallets, up to twice as many passengers and over 30% more aeromedical evacuation patients than the KC-135 aircraft fleet it is replacing.

SERVICES

ACAMS Airport Tower Solutions Provides ATIS for Italian Air Force

Oslo Norway-headquartered ACAMS Airport Tower Solutions has completed a contract for the delivery of a new i6 ATIS in Italy's Sardinia island, marking the fourth ACAMS ATIS delivery to Italian Air Force airbases. The ACAMS i6 ATIS system has been put into use at Decimomannu Air Base, hosting the International Flight Training School and also likely to become an airbase for the Italian Air Force F-35 fighter jets.

ACAMS i6 ATIS will provide the actual present weather situation, the state of the runway, as well as other pertinent information, which will enhance air traffic safety and efficiency, with relevant information being distributed automatically through the ATIS system.

"We are proud to team up with Eurelettronica Icas to supply the Italian Air Force with our industry leading ATIS solution," says Leiv Kreyberg, CEO at ACAMS Airport Tower Solutions. "We know that military air bases can sometimes be challenging, nevertheless ACAMS i6 ATIS is well established, with close to 250 systems deployed globally."

The ACAMS ATIS systems, already deployed at Pisa, Trapani and Galatia airbases will also be upgraded to the latest i6 ATIS version.

TECHNOLOGY

SITA Unveils Upgraded Global Wireless Solution

SITA has announced the launch of a new and improved version of its wireless solution, SITA Mobile Data Access (MDA) 2.0. This enhanced solution provides secure, reliable, and business-grade cellular eSIM and SIM connectivity across all 2G, 3G, 4G, and 5G technologies, extending global reach to over 200 countries.

"Local mobile networks often lack comprehensive coverage and service level agreements, which are essential for operational apps used in the aviation ad transportation sectors," says Martin Smillie, Senior Vice President for Communications and Data Exchange. "Our customers demand reliable, high-quality service, and cost control both on and off-site to maintain operational efficiency. SIA MDA 2.0 offers a seamless, secure, and one-stop solution for global cost-efficient connectivity."

SITA MDA 2.0 connects to over 700 roaming partners globally, a dedicated online portal that consolidates multi-source information, traffic filtering to control costs and dedicated 24/7 support.

INDUSTRY

Thales and Garuda Aerospace Sign MoU for Drone Operations Security

Thales and Garuda Aerospace have signed a Memorandum of Understanding (MoU) to promote the development of the Indian drone ecosystem. Under the agreement, Thales will provide expertise in the field of Unmanned Traffic Management (UTM) solutions, UAV detection, and system integration, while Garuda Aerospace will bring its skills in the manufacture and use of UAV s as well as its expertise in the Indian market.

"The government is providing a robust foundation for the drone ecosystem, fostering opportunities for collaboration, innovation and growth," says Ashish Saraf, Vice President and Country Director, Thales in India. "We are proud to partner with Garuda Aerospace in paving the way for the development of advanced UTM systems in India by leveraging our extensive global experience and expertise in aeronautical solutions. This collaboration aligns well with the Aatmanirbhar Bharat (Self-Reliant India) vision, and seeks to support India in realising its ambition to become a major global hub for drones by 2030."

"We are thrilled to partner with Thales in driving technological innovations for the development of drones and drone-based applications in India," says Agnishwar Jayaprakash, Founder CEO, Garuda Aerospace. "Ever since Honourable Prime Minister Shri Narendra Modi ji launched 100 Garuda drones in 100 villages, we have scaled and cemented market dominance in the precision agri drone segment where 50% of agri drones in India is Garuda's. Equipped with the largest fleet in India coupled with Thales' UTM technology and their worldwide experience, Garuda Aerospace will aim to revolutionize the drone sector and play a key role in the transformation of India into a global drone powerhouse."

STANDARDS

Rohde and Schwarz's TS-RRM and TS8980 Meet Test Platform Approval Criteria -Pix

Rohde and Schwarz has blazed a trail by achieving test platform approval criteria (TPAC) for Non-terrestrial networks narrowband IoT (NTN NB-IoT) for radio frequency (RF) and radio resource management (RRM) conformance test cases. This is following the approval of the R&S TS-RRM and R&S TS8980 test platforms for every type of NTN NB-IoT test at the recent Conformance Agreement Group (CAG) Meeting No. 78 of the Global Certification Forum (GCF), which makes Rohde and Schwarz the only company to have activated both NTN NB-IoT RF and RRM work items in GCF.

This milestone achievement by Rohde and Schwarz allowed GCF to activate work item 336 in its device certification program, meaning that Rohde and Schwarz now supports the complete certification of Release 17 NB-IoT user equipment for NTNs.

The R&S TS-RRM and R&S TS8980 are conformance test systems designed to facilitate NB-IoT certification across LTE and other radio access technologies. The R&S TS-RRM is a fully automated conformance test system for running RRM conformance test cases and runs 5G NR and LTE inter-radio access technologies RRM test cases for verifying wireless devices. ■

Image Credit: SAAB AB.

Remote Virtual Tower Technologies:

Revolutionising Air Traffic Management

By Adeyinka Olumuyiwa Osunwusi

THE INCREASING DIGITALISATION, AUTOMATION AND VIRTUALISATION OF THE GLOBAL AVIATION SYSTEM IN GENERAL AND THE AIR NAVIGATION SERVICE SECTOR IN PARTICULAR IS INTRODUCING INNOVATIVE OPPORTUNITIES FOR CONDUCTING AVIATION OPERATIONS IN A SAFE, SECURE, SUSTAINABLE AND EFFICIENT MANNER. LEVERAGING ARTIFICIAL INTELLIGENCE, OPPORTUNITIES ARE ALSO EMERGING FOR SMARTER AIRPORTS AND INTELLIGENT AIR TRAFFIC MANAGEMENT. WITH THE EXISTING AND EMERGING POT-POURRI OF TECHNOLOGICAL AFFORDANCES, EXPECTATIONS ARE GROWING CONCERNING THE APPLICABILITY OF AVAILABLE REMOTE SENSING SOLUTIONS FOR COST-EFFECTIVE AND SEAMLESS AIR TRAFFIC MANAGEMENT.

With the continuing growth in air traffic volumes across the vast swathes of the global airspace coupled with issues surrounding the relentlessness of galloping operating costs vis-à-vis the dilemma regarding the maintenance of a delicate balance in the face of contradictory CAPEX, OPEX and revenue indices, air navigation service providers (ANSPs) across the world are continually looking for innovative ways to up the game in terms of operational safety and efficiency, meet the ever-evolving needs of day-to-day operations, ensure a more robust utilisation of resources, and, more importantly, stabilise their bottom line without necessarily harming the economies of users of air navigation services.

When it comes to the provision of both air navigation and airport services, the plasticity of certain dynamics appears to be hardening just as operating characteristics are becoming increasingly complex. Operating and associated costs are characteristically fixed and in most instances these costs have been maintaining a skyward trajectory. In some instances, the realities surrounding the operation of certain small and medium-sized airports paint a gloomy picture so much so that some of these airports have been forced to maintain fixed – and often short – opening hours.

FREQUENTIS:
Pushing Back the Frontiers of RDT Technology

More than any other technology-enabled air navigation services/air traffic management (ANS/ATM) solution out there, remote digital tower (RDT) services and technologies require a blend of out-of-the-box implementation strategies that are tailored towards implementing applicable International Civil Aviation Organization (ICAO) recommendations and specifications relating to harmonisation, standardisation, operational efficiency, scalability and interoperability. For FREQUENTIS, a global player in the control centre communication and information systems arena, an integrated approach to the development and implementation of RDT solutions is central not only to aligning with industry standards but also to meeting the growing needs of customers.

"Our ONE ATM initiative has streamlined our product portfolio to provide integrated solutions to our customers," says Michael Ellinger, Strategic Product Manager, ATM Tower, Frequentis. "RDT and video technology seamlessly integrate with our flight strips solution, surveillance products (PRISMA and TowerPad), and voice communication solutions."

OUR ONE ATM INITIATIVE HAS STREAMLINED OUR PRODUCT PORTFOLIO TO PROVIDE INTEGRATED SOLUTIONS TO OUR CUSTOMERS - Michael Ellinger, Strategic Product Manager, ATM Tower, FREQUENTIS.

"This solution is highly adaptable and scalable, suitable for small airports and large hubs alike," Ellinger adds. "We have established a team to align these products and pre-integrate them to roll out customer solutions efficiently and quickly."

The ATM systems industry is seeing quite a number of dynamic changes unfolding in the RDT world. These changes, expectedly, have quite a lot to do with the increasing pace of technological advancements.

"There is increasing interest in the classical Remote Digital Tower (RDT) use case for small and medium sized airports. The technology is mature and it is becoming an important part of how to strategically provide Air Traffic Control (ATC) service to such airports," says Ellinger. "On the technology side, we have seen an improvement in regards to the resolution and image quality of RDT cameras as well as advanced capabilities in image processing in order to extract more data from the image to provide support to the user. We are also witnessing a significant trend towards integrating all elements and applications within the digital tower, offering users a harmonized HMI and unified capabilities."

Although already well-positioned from the standpoint of providing cutting-edge RDT solutions, Frequentis' RDT profile received additional boost recently when the German air navigation service provider (ANSP), DFS Deutsche Flugsicherung, awarded FREQUENTIS DFS AEROSENSE a contract for the installation of a test and validation system for a digital tower solution at the Munich Airport. Ellinger says in respect of the project: "In an initial project phase, the potential and suitability of the virtual tower for larger airports will be determined and validated from both an operational and technical perspective. Subsequently, specific use cases can be defined, for example, setting up a virtual tower as an interim system during the renovation of the control tower at Munich Airport required in the coming years."

The Vienna Austria-headquartered FREQUENTIS DFS AEROSENSE GmbH is a joint venture between Frequentis and a wholly owned subsidiary of DFS Deutsche Flugsicherung, DFS Aviation Services GmbH (DAS). The joint venture initiative targets the provision of turnkey advanced remote sensing solutions deploying cutting-edge virtual tower systems from Frequentis alongside proven expertise as well as operational and regulatory concepts from DFS.

"Frequentis and the German ANSP DFS Deutsche Flugsicherung GmbH, through its wholly owned subsidiary DFS Aviation Services, established FREQUENTIS DFS AEROSENSE," Ellinger explains. "In this successful joint venture, we combine technical with operational expertise and jointly guide our customers through this change process."

LEVERAGING ARTIFICIAL INTELLIGENCE

Aviation industry players across different sectors are gradually leveraging artificial intelligence - as well as its derivatives, deep learning (DL) and machine learning (ML) – for the implementation of smart and intelligent solutions. In recent times, there has been a flurry of activities along this path in the air traffic management industry, with Frequentis also getting involved to a great extent.

"We already incorporate AI technology in our products for purposes such as image and pattern recognition. We conduct ongoing research to enhance data extraction and increase automation to better support our users," says Ellinger. "Additionally, we are active in standardisation to establish a safe and reliable framework for implementation in line with national regulators and international organisations, for example, EASA."

In the first quarter of 2023, Frequentis announced that it was collaborating with the Austrian Institute of Technology (AIT), Graz University of Technology (TU Graz), and Airport Vienna on a research project christened Smart Assistant for Enhanced Remote Digital Tower (SAFER). The project - funded under the Austrian Aeronautics Research and Technology Programme (Take Off) – is aimed at developing smart assistive technology for RDT vision systems with the overall objective of increasing efficiency as well as ensuring safety in RDT operation through multimodal artificial intelligence. Within the project's operational framework, Frequentis assumes the leading role with the core responsibility revolving around processing, data collection and management, software integration, evaluation, and validation, while Airport Vienna is responsible for providing operational use cases and data. The AIT Centre for Vision, Automation and Control is responsible for project conception and AI development, while TU Graz assumes responsibility for providing graphics and vision expertise.

FORGING PARNERSHIPS, ENGAGING STAKEHOLDERS

Strategic partnerships and a much more symbiotic engagement with users are key components of Frequentis' enduring business philosophy.

"Strategic partnerships are of special importance for Frequentis. Delivering high-quality RDT solutions that span the full breadth and depth of an industry requires companies to work together with partners," says Ellinger. "In an ever growing and evolving world, selected partners are of key importance to complement our own ability to create RDT solutions and services in the most efficient and effective manner for our customers."

"Frequentis actively selects and manages its strategic partnerships with the goal of strengthening and growing our business portfolio," Ellinger adds. "In return, we empower our partners to grow their own business. In our global RDT partnerships we follow the goal to create a win-win scenario for all stakeholders involved."

Aside from building partnerships on all levels to strengthen its hand in the global RDT market, Frequentis has also emplaced a robust process that prioritises user engagement at all levels.

"We have established a dedicated implementation process for the deployment of Remote Digital Tower solutions," Ellinger affirms. "Stakeholder management is a core aspect of such deliveries, with users and other stakeholders engaged from the start of the changeover process."

"Close involvement of users during system specification and early validation phases provides valuable feedback, enabling us to tailor the solution to their specific needs. This approach in turn leads to greater user acceptance and satisfaction. Various best practices have emerged from our projects in Germany, the UK, and the US, which are now used as valuable input for new projects," Ellinger concludes.

But all that appears to be problems in passing as one promising solution appears to be gaining traction the world over. This solution involves an air traffic management cum airport operational design whereby one or more geographically dispersed airports are accorded remote control capabilities through the deployment of remote sensing technologies that enable air traffic in and out of such an airport or airports to be remotely controlled from a remote tower centre with almost the same level of visibility. Today, this unique operational concept goes by a number of nomenclatures from Remote Tower Control (RTC) operation, Remote Virtual Tower (RVT) operation and Remote Tower Service (RTS) to Remote Digital Tower (RDT) operation and Digital Remote Tower (DRT) operation.

To be sure, ANSPs the world over appear to be giving more than a passing attention to this promising solution not only because of its novelty and innovative concept but also because of the pluses that it offers, including service centralisation, cost efficiency, operational flexibility, operational efficiency and resilience, enhanced safety, and enhanced contingency management.

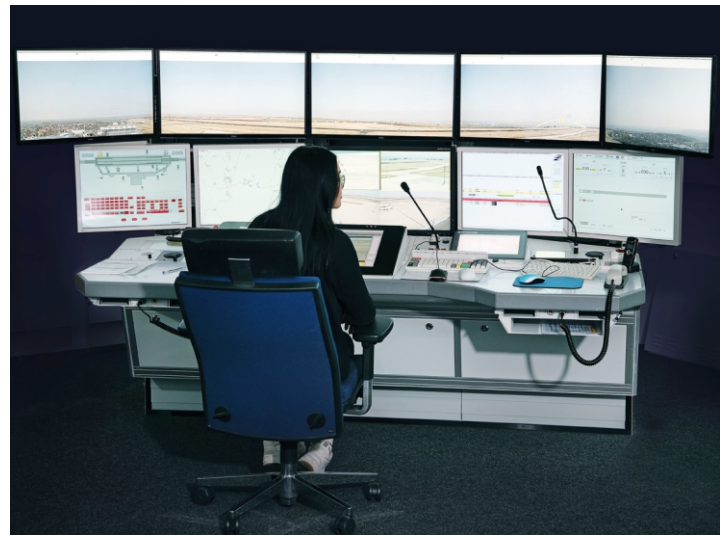
"Every major ANSPs do have roadmaps for the centralization of air traffic control operations and enabling the management of multiple airports from a single location," says Senthilvel Balasubramanian, International Federation of Air Traffic Safety Electronics Associations (IFATSEA) Regional Director for Asia Pacific. "RDT is one such technology that makes their dream possible. So, RDT will play a major role in the coming years."

" There is increasing interest in the classical Remote Digital Tower (RDT) use case for small and medium sized airports," says Michael Ellinger, Strategic Product Manager, ATM Tower for Frequentis. "We are also seeing a heightened interest coming from larger airports to use the technology as an enhancement or contingency solution and at later stage even use it instead of the conventional tower.

IN THE BEGINNING

Despite the claim in a Working Paper (AN-Conf/12-WP/130) presented by Japan at the Twelfth ICAO Air Navigation Conference in 2012 regarding the remote provision of aerodrome flight information services (AFIS) in Japan since 1974, Ornskoldsvik Airport (IATA: OER, ICAO: ESNO), located 24km northeast of Ornskoldsvik, Sweden, was indisputably the world's first remotely operated airport, using the Remote Tower Services (RTS) system jointly developed by the Swedish company, SAAB AB, and the Swedish ANSP, LFV. On 21 April 2015, the first aeroplane flight to be operated via remotely operated air traffic control landed successfully on the runway of the small Swedish airport. The landing was controlled from LFV's Remote Tower Control (RTC) centre located some 123km (76 miles) away in Sundsvall, Sweden.

The April 21, 2015 operations in Ornskoldsvik and Sundsvall was a consequence of a safety approval granted LFV by the Swedish Transport Agency on 31 October 2014 for the remote operation of Ornskoldsvik Airport from LFV's Sundsvall RTC centre. And what's more: this approval was also the world's first operational approval for remotely operated air traffic services.



RTC Centre. *Image Credit: DFS*

"Remote Tower Services is a development programme that we are very proud of," Olle Sundin, the then Director General of LFV, had commented on the Ornskoldsvik event. "We are the first operator in the world to receive operational approval and there is a lot of interest among our customers in Sweden and around the world. RTS is an important product for us and our partners. It gives us a good position and strong competitiveness."

Also adding his voice, Hakan Buskhe, the then President and CEO of SAAB AB, had said: "We see a great interest from both small and large airports that have a need for remote tower services in order to address the challenges that they face."

REMOTE TOWER SERVICES

The Remote Tower Services (RTS) concept is essentially a strategic paradigm shift enabled by technological innovations. It marks a futuristic shift from the conventional air traffic control (ATC) paradigm established sometime in 1920 at the United Kingdom's Croydon Airport, which later gave birth to Northolt, Heathrow and Gatwick. This conventional paradigm – representing the present ATC practices – mandates the localisation of an ATC tower and allied services at the particular airport or aerodrome being controlled.

To be sure, the primary objective of remote tower solutions is to enable air traffic control and allied services to be provided from a central remote tower services point, which is normally located at quite some distance from the remote airport or airports under control. What this implies is that air traffic controllers and other flight information services personnel are not required to be physically present at the airports under remote air traffic control. Rather, they will be stationed at a central location – a remote tower control (RTC) centre – where they will rely on video-based technology to have a clear visual presentation of the remotely operated airports. This involves the use of a remote tower module at the RTC, which includes Controller Working Positions (CWPs), air traffic management (ATM) systems, and visual display screens.

The game changer in this circumstance, of course, appears to be the deployment of cutting-edge RDT solutions, incorporating critical enhancements. But, Frequentis, a global player in the control centre communication and information systems industry, believes that this is not all that is required to excel in the RDT arena.

"Cutting-edge technology is just one part of what is needed for a successful remote tower project," says Frequentis' Michael Ellinger. "The introduction of remote tower solutions is more than just a system supply – it is a change project affecting multiple disciplines and customer areas."

"Our solution is open, flexible, and extendable over time. Typically, our customers begin by introducing remote tower technology with a one-to-one airport replacement, operating in single mode. The solution is already designed to support flexible airport switching and can be upgraded to parallel multi-mode," Ellinger adds.

The sheer complexity of the operational setting required for seamless remote air traffic control services, therefore, points to the need for an innovative approach to implementing the RDT technology, which Frequentis claims to have mastered over time.

"Our ONE ATM initiative has streamlined our product portfolio to provide integrated solutions to our customers. RDT and video technology seamlessly integrate with our flight strips solution, surveillance products (PRISMA and TowerPad), and voice communication solutions," says Ellinger. "This solution is highly adaptable and scalable, suitable for small airports and large hubs alike. We have established a team to align these products and pre-

integrate them to roll out customer solutions efficiently and quickly."

THE TECHNOLOGY

Operationally speaking, air traffic controller situational awareness and controller conflict detection capabilities are key elements in remote tower operations. As a result of the fact that, in an RTS scenario, OTW (out-of-the-window) view is replaced by visual presentation made available to the controller on the RTS workstation, it is imperative that the technology deployed for remote tower operations should be capable of sufficiently replicating air traffic controller situational awareness aside from providing a reliable means of visual observation so that air traffic service can be provided and maintained to at least the same level as is in a situation where the controller is physically present in a conventional tower. Interestingly, the increasing advancements particularly in the areas of RDT and video technologies are providing an unbelievable level of reliability. And what's more: Frequentis, like other players in the RDT industry, has been leveraging these enhanced technologies to provide cutting-edge solutions.

"On the technology side, we have seen an improvement in regards to the resolution and image quality of RDT cameras as well as advanced capabilities in image processing in order to extract more data from the image to provide support to the user," says Ellinger. "We are also witnessing a significant trend towards integrating all elements and applications within the digital tower, offering users a harmonized HMI and unified capabilities. Features such as automatic object detection, tracking and object following by the PTZ cameras have been tested in various operational conditions and used by our large customer base for years."

Frequentis boasts a number of attributes that set the company's RDT solutions apart in the global ATM market. Ellinger explains: "Setting our RDT solutions apart in the global ATM market is our integrated product portfolio covering all required capabilities such as video based visualisation, surveillance, flight data handling and voice and network solutions. Our extensive experience in the market, allowing us to adapt our products accordingly to specific customer requirements is a yet another attribute."

The remote tower operation normally involve the implementation of a wide range of interconnected sub-systems. There are usually three segments: equipment at the controlled airport or airports, a remote tower module at a central remote tower centre (RTC), and a transmission channel in between the RTC and the controlled airport or airports. Fundamentally, two broad types of equipage can be identified – the Primary or Basic Equipage, and the Secondary or Additional Equipage.

The primary remote tower sub-systems include components for visual presentation, binocular functionality, data/voice communication, visual communication, remotely controlled aerodrome sound reproduction and aerodrome management and control tools.

A critical component of the secondary equipage is the installation of infrared technology or night-vision lenses and other sensors to aid night and low visibility operations. There is also the technology for ensuring three dimensionally-augmented overlays onto the visual presentation.

As part of the primary equipage, there is an assembly of high definition fixed and movable cameras and sensors that effectively serve as replacements for conventional tower. These are mounted on a camera tower or communication and navigation equipment masts. The fixed cameras are meant to capture the main display, while the movable cameras, typically one or more Pan-Tilt-Zoom (PTZ) cameras capable of remote directional and zoom control, are used for binocular functionalities as well as the automatic detection and tracking of movements in the maneuvering areas of the aerodrome being controlled. The camera tower will normally feature signal light guns, which could be used as a backup in the event of radio communication failure.

LEVERAGING ARTIFICIAL INTELLIGENCE

There is much buzz in air navigation services realms today regarding the sheer imminence of a large-scale incursion of artificial intelligence (AI) into the techno-operational landscapes of the aviation ecosystem. And OEMs in the DRT market appear to be leveraging AI on a wider scale today.

"We already incorporate AI technology in our products for purposes such as image and pattern recognition. We conduct ongoing research to enhance data extraction and increase automation to better support our users," says Ellinger. "Additionally, we are active in standardisation to establish a safe and reliable framework for implementation in line with national regulators and international organisations, for example, EASA."

It is on record that Frequentis had, sometime in 2023, joined forces with the Austrian Institute of Technology (AIT), Graz University of Technology (TU Graz), and Airport Vienna on a research project christened Smart Assistant for Enhanced Remote Digital Tower (SAFER). The project - funded under the Austrian Aeronautics Research and Technology Programme (Take Off) – is aimed at developing smart assistive technology for RDT vision systems with the overall objective of increasing efficiency as well as ensuring safety in RDT operation through multimodal artificial intelligence.

THE GLOBAL RDT MARKET: ADOPTION AND DEPLOYMENTS

Given the ATM industry's continuing addiction with the conventional air traffic services cum airport operational model established in the UK in 1920, questions have been asked widely as to the level of acceptance and adoption of RDT solutions all over the world.

"The market has moved beyond early adopters, and the technology is now widely used by customers in Europe, Australia, and North America," says Ellinger. "We are also seeing a growing interest from emerging countries in South America and Parts of Asia."

Traditionally, the success of an innovation lies in its rate of adoption and deployment. But, as desirable as the RDT concept is, some stakeholders still entertain the fear that there are still many rivers to cross.

"Though some countries are actively testing and deploying remote digital towers in the region, I see some challenges that hamper the momentum among developing nations," says Senthilvel Balasubramanian concerning the Asia Pacific region. "Let me give a few examples such as navigating required regulatory and safety standards, ensuring that RDT systems meet the required criteria for operational safety and reliability, ensuring interoperability with the existing high-cost automation systems they already have as well as initial investment cost and most importantly the capability to ensure robust cybersecurity measures."

LOOKING FORWARD

In terms of adoption, the future is really looking very bright for the RDT market. Aside from the involvement of a growing number of OEMs like FREQUENTIS, SAAB AB, Searidge Technologies and Indra, an increasing number of ANSPs are also joining the league of service providers such as Germany's DFS, Denmark's Naviair, Sweden's LFV, Australia's Airservices Australia, and Norway's Avinor in an attempt to leverage the maximum potential of RDT technologies.

"Maybe in 10 to 20 years from now we may see only digital towers globally. The probability is quite high," says Senthilvel Balasubramanian. "Technological advancements in cameras, data transmission and processing technologies, and operational benefits will slowly promote digital towers among developing and smaller ANSPs also in the future." ■

CHAYMAE MAJDOUBI:
AI TECHNOLOGIES IN AVIATION

Chaymae Majdoubi is an Air Traffic Safety Electronics Engineer (CNS Engineer) working with the Moroccan Airports Authority. A graduate of the prestigious Mohammed VI International Academy of Civil Aviation in Casablanca, Morocco, Chaymae is currently pursuing a Ph.D. programme in Data Security for big data systems using Artificial Intelligence at the Ibn Tofail University. She is also a Certified ISO 27032 Cybersecurity Lead Manager. The Managing Editor of *Air Traffic Safety Electronics International*, Adeyinka Olumuyiwa Osunwusi, PhD, caught up with Chaymae recently and here's what she had to say:

With the continuing geometrical increases in global air traffic, how significant do you see the tasks and responsibilities of today's ATSEPs?

The rapid growth of global air traffic has greatly increased the significance of Air Traffic Safety Electronics Personnel (ATSEP) in managing and safeguarding air traffic control systems. As air traffic systems become more complex, ATSEPs play a crucial role in maintaining system accuracy and preventing errors. Their responsibilities, which include specifying, procuring, installing, calibrating, testing, and certifying ground electronic systems, are essential for ensuring the integrity and reliability of air traffic control services.

Additionally, their skills in troubleshooting and resolving technical issues are vital for minimizing system downtime and ensuring continuous air traffic management. Given the rising demands on air traffic control systems, the expertise of ATSEPs is increasingly important for safe and efficient air traffic management. Investing in their training and development is crucial to keep pace with the evolving needs of the industry.

What do you think about the increasing digitalization, automation and virtualization of aviation systems especially in the light of the need to ensure the continuing safety, security and efficiency of aviation operations?

The increasing digitalization, automation, and virtualization of aviation systems mark a significant shift in the industry's operational landscape, bringing both opportunities and challenges. On the positive side, these advancements can enhance safety, security, and efficiency by reducing human error, optimizing resource allocation, and enabling data-driven decision-making. Virtualization, in particular, offers cost-effective and environmentally friendly options for testing, simulation, and training. However, the growing dependence on complex digital systems and automation introduces new risks, such as cybersecurity threats, potential system failures, and the need for specialized expertise to manage these technologies. Additionally, human error remains a concern in the development and operation of automated systems. To ensure ongoing safety, security, and efficiency, a proactive and comprehensive approach is essential. This includes implementing strong cybersecurity measures, rigorous testing and validation protocols, and thorough training for personnel. Cultivating a culture of safety and encouraging collaboration among industry stakeholders, regulators, and researchers will be key to successfully navigating the complexities of this evolving environment.

"GIVEN THE RISING DEMANDS ON AIR TRAFFIC CONTROL SYSTEMS, THE EXPERTISE OF ATSEPs IS INCREASINGLY IMPORTANT FOR SAFE AND EFFICIENT AIR TRAFFIC MANAGEMENT. INVESTING IN THEIR TRAINING AND DEVELOPMENT IS CRUCIAL TO KEEP PACE WITH THE EVOLVING NEEDS OF THE INDUSTRY" – Majdoubi.

And what dynamic changes are you seeing today regarding the techno-operational aspects of CNS/ATM in a cyber-centric world?

The techno-operational landscape of CNS/ATM is experiencing a significant shift in response to the growing cyber-centric nature of the aviation industry. The increased reliance on interconnected systems has heightened vulnerability to cyber threats, making comprehensive cybersecurity frameworks—encompassing threat assessment, vulnerability analysis, and incident response—crucial for maintaining safety and efficiency. Concurrently, the push for enhanced efficiency, capacity, and environmental sustainability is driving initiatives like NextGen and SESAR, which aim to create integrated, network-centric air traffic management systems using technologies like ADS-B, PBN, and SWIM.

The rise of UAVs and RPAS is also prompting the development of advanced CNS/ATM systems to safely integrate these aircraft into the airspace. Additionally, environmental concerns are shaping CNS/ATM procedures, with innovations in dynamic airspace management and 4D trajectory optimization aimed at reducing emissions. Emerging technologies, including AI, machine learning, and IoT, are expected to further revolutionize CNS/ATM by enhancing decision-making accuracy and creating more connected systems. Overall, the dynamic changes in CNS/ATM are a response to the demands of a cyber-centric world, requiring a proactive and collaborative approach to ensure continued safety, efficiency, and sustainability in aviation operations. The advent of advanced technologies such as artificial intelligence, machine learning, and the Internet of Things (IoT) is expected to play a pivotal role in shaping the future of CNS/ATM. For instance, the application of AI and machine learning algorithms can enhance the accuracy and efficiency of air traffic management decision-making, while IoT technologies can enable the development of more integrated and connected CNS/ATM systems.

In conclusion, the techno-operational aspects of CNS/ATM are undergoing a significant transformation in response to the evolving demands of a cyber-centric world. To ensure the continued safety, efficiency, and sustainability of aviation operations, it is essential to adopt a proactive and holistic approach to addressing these challenges, leveraging advanced technologies and fostering collaboration between industry stakeholders, regulators, and researchers.

There is much buzz today in the aviation industry regarding the imminence of a large-scale incursion of AI technologies into the global aviation system. What are your thoughts regarding the possibility of such a large-scale incursion?

The prospect of a large-scale incursion of AI technologies into the global aviation system is both exciting and transformative, with the potential to significantly enhance safety, efficiency, and decision-making. However, this process should be approached with maturity, starting with the integration of AI into non-critical tasks and fostering collaboration across various sectors. AI can revolutionize predictive maintenance by analyzing sensor data to predict and prevent issues, thereby reducing downtime and enhancing safety. In air traffic control, AI can optimize flight routes by analyzing real-time weather and traffic data, leading to reduced fuel consumption and lower emissions. Additionally, AI-powered chatbots can improve the passenger experience by offering personalized support. Importantly, AI should be viewed as a tool that complements human critical thinking, making tasks more efficient while allowing humans to focus on higher-level decision-making.

"EMERGING TECHNOLOGIES, INCLUDING AI, MACHINE LEARNING, AND IoT, ARE EXPECTED TO FURTHER REVOLUTIONIZE CNS/ATM BY ENHANCING DECISION-MAKING ACCURACY AND CREATING MORE CONNECTED SYSTEMS" – Majdoubi.

And how significant would such an incursion be for the CNS/ATM working environment?

The large-scale integration of AI technologies into the CNS/ATM working environment would be profoundly significant, bringing widespread changes across air traffic management, air navigation services, and the broader aviation ecosystem. Key impacts include enhanced decision-making through real-time data analysis, allowing for better safety, efficiency, and reduced delays. AI will automate routine tasks, enabling human controllers to focus on more complex responsibilities, which could improve productivity and morale. It will also enhance situational awareness and collaboration among stakeholders, such as controllers, pilots, and operators. However, this shift will create new job roles and training needs, as personnel must learn to work effectively with AI systems. Additionally, the reliance on AI will introduce new cybersecurity risks, necessitating strong security measures. Overall, the adoption of AI will require a cultural shift within the CNS/ATM community, as trust in AI's capabilities becomes essential.

How would a large-scale adoption of AI technologies in the CNS/ATM realm impact the tasks and responsibilities of ATSEPs?

The large-scale adoption of AI technologies in CNS/ATM systems will significantly reshape the roles and responsibilities of Air Traffic Safety Electronics Personnel (ATSEPs). As AI takes over routine tasks like data analysis and predictive maintenance, ATSEPs will transition to more strategic roles that emphasize their specialized skills. This shift will require ATSEPs to acquire new competencies in AI literacy, data interpretation, and human-AI collaboration. By integrating AI into existing systems and developing new procedures for human-AI interaction, ATSEPs will be able to focus on higher-value activities that leverage their expertise, ensuring a seamless transition to an AI-driven CNS/ATM environment.

And what would you say regarding the reverberating effects on the competence, training and certification of ATSEPs?

AI is a powerful tool that ATSEPs should approach with careful consideration, but it is important not to resist technological advancements. The integration of AI into the aviation sector is inevitable, and it will likely take on various forms over time. Given that ATSEPs primarily work with technology, it is crucial to stay open to emerging innovations and strategically plan to make AI an ally rather than a threat. This proactive approach can be achieved through continuous learning, targeted training, and regularly upgrading competencies to align with the evolving demands of the industry.

"EMERGING TECHNOLOGIES, INCLUDING AI, MACHINE LEARNING, AND IoT, ARE EXPECTED TO FURTHER REVOLUTIONIZE CNS/ATM BY ENHANCING DECISION-MAKING ACCURACY AND CREATING MORE CONNECTED SYSTEMS" – Majdoubi.

In the future, AI-related skills and knowledge may become a necessary component of ATSEP certification programs, serving as a valuable supplement to existing qualifications. By staying ahead of the curve, ATSEPs can ensure they remain relevant and effective in an AI-enhanced aviation environment.

Do you think that air traffic safety electronics professionals should be concerned about the possibility of the negative impact of AI adoption on job security?

Certainly, AI presents both opportunities and challenges for Air Traffic Safety Electronics Professionals (ATSEP). While concerns about job security are valid, it is essential to recognize that AI integration is becoming increasingly inevitable due to its numerous benefits, such as enhanced data analysis, improved operational efficiency, and even cybersecurity advancements. However, rather than shying away from AI, it is crucial to embrace it while proactively addressing the associated challenges.

To mitigate potential negative impacts, the development and implementation of new risk management strategies tailored to the AI-driven technological era are necessary. Additionally, fostering collaboration among various stakeholders - field personnel, researchers, and industry leaders - will be key to exploring different scenarios, identifying risks, and preparing for the future. This collaborative approach will help ensure that AI adoption enhances rather than threatens job security, ultimately leading to a more resilient and adaptable workforce.

And how will AI-enabled tools and interventions impact traditional ATSEP tasks such as corrective maintenance, predictive maintenance as well as the detection and resolution of operational abnormalities?

AI-enabled tools and interventions are set to significantly transform traditional ATSEP tasks. For corrective maintenance, AI diagnostics will streamline fault identification and resolution, reducing downtime and improving system availability. Predictive maintenance will benefit from AI-driven analytics that anticipate and prevent equipment failures, lowering costs and boosting reliability. In detecting and resolving operational abnormalities, AI-powered monitoring systems will provide real-time anomaly detection, allowing for swift responses and minimizing disruptions.

The adoption of AI will increase efficiency by automating routine tasks, improve accuracy by reducing human error, and enhance decision-making through data-driven insights. However, this shift will also present challenges, including the need for upskilling, effective data management, and learning to collaborate with AI systems while integrating human expertise. Embracing these AI advancements will enable ATSEPs to improve maintenance and operational effectiveness while navigating the complexities of new technology.

To address these challenges, ANSPs should implement clear AI governance frameworks, invest in human-centered design, and develop robust data management strategies. Collaboration and knowledge sharing should be encouraged, alongside investments in cybersecurity and resilience. Establishing comprehensive standards and regulatory frameworks is crucial, as is continuously monitoring and evaluating AI performance. By tackling these challenges with a balanced approach, ANSPs can facilitate a smooth transition to an AI-driven CNS/ATM environment, enhancing safety, efficiency, and capacity while managing potential risks and ensuring effective integration with existing systems in collaboration with other stakeholders.

ICAO, no doubt, emphasizes the sacrosanct nature of the human component in an automated working environment. What level of control do you think AI-powered operations should assume in a CNS/ATM working environment?

ICAO underscores the critical importance of human oversight in automated systems, which guides the level of control AI should have in CNS/ATM environments. A hybrid approach is ideal, where AI enhances human decision-making by managing routine and data-intensive tasks, while human controllers handle complex, high-stakes scenarios. AI should support decision-making by providing recommendations and insights, but human controllers must retain the ability to intervene or override AI actions when necessary.

In certain cases, AI can make autonomous decisions, such as optimizing flight trajectories, but these should always be subject to human review. A human-in-the-loop approach ensures that controllers can step in when AI is uncertain or lacks adequate data. Ongoing monitoring and evaluation of AI performance are crucial for maintaining safety and efficiency, enabling continual improvement and updates. This approach allows CNS/ATM operations to harness AI's advantages while preserving essential human oversight, ultimately enhancing safety, efficiency, and capacity in aviation.

"AI SHOULD SUPPORT DECISION-MAKING BY PROVIDING RECOMMENDATIONS AND INSIGHTS, BUT HUMAN CONTROLLERS MUST RETAIN THE ABILITY TO INTERVENE OR OVERRIDE AI ACTIONS WHEN NECESSARY" – Majdoubi.

Still talking about AI adoption in the ANS/ATM realm, what do you see as the biggest challenges for CNS/ATM operations in an AI-driven working environment? And what measures should ANSPs be looking at to overcome these challenges?

Integrating AI into CNS/ATM operations presents several challenges, including ensuring trust and reliability in AI decision-making, managing complexity and ensuring interoperability with existing systems, scaling to meet increasing air traffic volumes, addressing human factors and training needs, developing appropriate regulatory and standards frameworks, ensuring effective data-driven decision-making, and protecting against cyber threats.

Overall, how would you assess the future of AI technologies in the aviation industry?

The future of AI technologies in the aviation industry will rely heavily on collaboration among various stakeholders. Currently, AI is not yet suited for critical tasks but offers significant benefits in generating reports and predictive maintenance. The adoption of AI will be gradual, starting with defining its applications, performing preliminary tasks, and understanding training and implementation requirements.

It is essential to adhere to aviation industry standards and norms throughout this process. For Air Traffic Safety Electronics Personnel (ATSEP), AI should primarily be deployed to reduce work overload by automating routine tasks and checks, thus allowing more time for critical thinking and problem-solving. Key considerations include how AI will affect daily responsibilities, enhance safety and efficiency, and integrate with existing systems. Staying informed about regulatory changes and training needs is crucial to ensure compliance and effective implementation. Additionally, addressing ethical issues such as data security and bias will be vital for maintaining operational integrity and continuity. ■

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ATSEI REGIONAL FOCUS

ASIA PACIFIC AVIATION:

Cashing In On Growing Opportunities

AN Air Traffic Safety Electronics International INDUSTRY ANALYSIS

THE ASIA PACIFIC REGION REMAINS CONSIDERABLY RESILIENT AND GLOBALLY ALIGNED WHEN IT COMES TO THE TECHNO-OPERATIONAL ASPECTS OF THE REGIONAL AVIATION INDUSTRY. ALTHOUGH THERE ARE STILL POCKETS OF INADEQUACIES HERE AND THERE, THE GROWING PROSPECTS IN TERMS OF EMERGING OPPORTUNITIES ARE JUST THE PERFECT ELIXIR THAT THE REGION NEEDS TO FORGE AHEAD. AND, TO BE SURE, THE ASIA PACIFIC REGION APPEARS STOUTLY DETERMINED TO BE THE ULTIMATE HUB OF GLOBAL AVIATION.

Image Credit: pexels.com

Talking about international aviation operations, Asia Pacific (APAC) is definitely a region where the affordances of growing opportunities in the aviation ecosystem are harnessed based on a regional need for global alignment, whilst also leveraging innovations and technologies.

"The Asia-Pacific (APAC) region is closely aligned with global trends. I see lots of inspiration and takeaways from NextGen and SESAR in terms of revolutionizing air traffic management with advanced technologies, enhancing efficiency and safety. Whether AI or remote tower technologies, they are catching up all over the world globally though they are initiated mostly in Europe or in the USA," says Senthilvel Balasubramanian, the Asia Pacific Regional Director for the International Federation of Air Traffic Safety Electronics Associations (IFATSEA). "One good example I can refer to is ASEAN Single Aviation Market, which is an APAC effort like the European Union's Single European Sky initiative with both aiming to harmonize regulations and liberalize the airspace."

The ASEAN Single Aviation Market (ASAM) initiative, endorsed by the 13th ASEAN Summit, is clearly an effort tailored towards further strengthening the hand of the Asia Pacific (APAC) region in relation to the growing opportunities in the aviation realm as well as the region's global alignment objectives. The initiative integrates the APAC region's single aviation market objectives in respect of air services liberalisation, aviation security, aviation safety, airline ownership and control, competition laws, airport user charges, tariffs, consumer protection, and air traffic management (ATM). It is also an embodiment of the ASEAN Open Skies policy, which incorporates a number of frameworks, including the ASEAN Multilateral Agreement on the Full Liberalisation of Passenger Air Services (MAFLPAS), the ASEAN Multilateral Agreement on the Full Liberalisation of Air Freight Services (MAFLAFS), and the ASEAN Multilateral Agreement on Air Services (MAAS).

The APAC region's leaning towards a global alignment of policies and operations is not restricted to the forging of regional partnerships but traverses the realms of infrastructure and operational concepts.

"Similarly, the PBN and FRA concepts are being adopted in APAC as well with a global push towards creating seamless airspace across borders," Balasubramanian adds. "The use of smart technologies, such as automated baggage handling and biometric screening, is becoming a widespread feature of the global ecosystem. The growth of low-cost carriers (LCCs) in the APAC is very much comparable with the growth of LCCs in Europe and the United States."

CHANGING TERRAINS

As is the case with virtually all regions of the world, APAC is currently witnessing dynamic changes in the workings of the region's aviation industry on all levels.

"From the ANSP point of view, the dynamic changes I see include the adoption and implementation of space-based ADS-B as well as the increasing deployment of remote and digital tower technologies," says Balasubramanian. "Countries are pioneering the use of Artificial Intelligence (AI) in air traffic management automation systems that can predict congestion and reroute traffic in real-time to optimize airspace usage. The region is also progressively transitioning to Performance-Based Navigation (PBN) and the concept of Free Route Airspace (FRA)."

The changes being witnessed don't just appear to be limited to the air navigation service provision cum air traffic management terrains but extend far beyond airport operations and facilitation. According to Balasubramanian: "When we look at airport operations, I can list a few points. With the rapid growth in passenger numbers, many airports in the Asia-Pacific region are undergoing significant expansion projects to increase capacity. These include building new terminals, expanding existing ones, and constructing additional runways. Airport expansion projects are increasingly incorporating sustainable practices, such as green building standards, energy-efficient designs, and measures to minimize environmental impact. There is also the transition to electric ground support equipment (GSE) and vehicles to reduce emissions from airport operations. Implementation of facial recognition technology for seamless passenger identification at check-in, security checkpoints, and boarding gates also constitute another change aspects."

"One can also mention the deployment of automated self-service bag drop systems to streamline the baggage check-in process. Another area of change involves the integration of Internet of Things or IoT devices throughout the airport to have smart lighting and remote monitoring and management of different systems," Balasubramanian adds.

A VIBRANT REGION

The aviation industry in the APAC region has, no doubt, recorded tremendous growth over

the past few years. These upbeat developments appear to stand out in some APAC countries that have come to be known for their vibrancy in virtually all the ramifications of aviation operations.

"In the Asia-Pacific region, several countries stand out as centers of action in terms of infrastructure, regulations, and operations, reflecting significant advancements and leadership in the aviation sector," says Senthilvel Balasubramanian. "China, Singapore, Australia, Japan and India can be highlighted in some key areas. China leads in large-scale infrastructure projects. Singapore excels in smart airport initiatives. Australia leads in remote tower technology. Japan leads in advanced airport operations, while India is focusing on airport development for the purpose of accommodating the growth of regional connectivity with low-cost carriers."

But, when it comes to the 'Effective Implementation' (EI) scores for these front runner APAC countries under the International Civil Aviation Organization's (ICAO) Universal Safety Oversight Audit Programme (USOAP) in respect of the various categories from legislation to aerodrome, the clear leader is Singapore. Juxtaposed against the Global Average of 77.27, 71.39, 73.32, 71.08, 83.24, 54.16, 65.12, and 63.07 percentage points respectively across the Legislation, Organization, Licensing, Operations, Airworthiness, Accident Investigation, Air Navigation Services, and Aerodrome categories, Singapore's EI scores for the 2022 mission year stand at 98.13% for the Air Navigation Services category and 100% across the Legislation, Organization, Licensing, Operations, Airworthiness, Accident Investigation and Aerodrome categories. Australia (2023 mission year) scored 100, 91.67, 89.74, 80, 91.72, 95.06, 93.69, and 87.29 percentage points across the Legislation, Organization, Licensing, Operations, Airworthiness, Accident Investigation, Air Navigation Services, and Aerodrome categories respectively compared to India's 2022 mission year records of 100, 72.73, 84.71, 94.02, 97.06, 64.56, 72.73, and 92.68 percentage points. China (2021 mission year) recorded EI scores of 80.95, 100, 98.55, 85.15, 87.73, 65.28, 65.12, and 88.19 percentage points across the Legislation, Organization, Licensing, Operations, Airworthiness, Accident Investigation, Air Navigation Services, and Aerodrome categories respectively as against Japan's 2010 mission year scores of 90.48, 88.89, 84.06, 88, 96, 86.76, 82.08, and 92.24 percentage points across the same categories respectively.

China is the APAC front runner when it comes to the domestic air passenger market. According to the IATA's Air Passenger Market Analysis (June 2024), China triumphed over both India and Japan with 11.2 percentage points and 5.5% RPK (Revenue Passenger-Kilometer) growth year-on-year as against India's 1.8% share and 5.2% RPK growth and Japan's 1.1% market share and -0.2% RPK growth.

Talking about the air freight arena, the International Air Transport Association (IATA), in its Air Cargo Market Analysis for June 2024, reported a 15.6% increase in international air cargo volumes compared to June 2023, with the Asia Pacific region recording the highest share of 33.3% in terms of total air cargo market year-on-year and closely followed by North America with 26.9% share and Europe with 21.4% share. In terms of international cargo market year-on-year, Asia Pacific-registered airlines represent the highest with 29.8%. They also represent the highest annual growth rate in terms of international cargo (measured in CTK) with 18.5% growth rate year-on-year.

In terms of total air cargo market (measured in CTK), the IATA Analysis shows Asia Pacific recording the highest showing as at June 2024 with 17 percentage points year-on-year. With respect to the 14.1% demand increase year-on-year experienced by the airline industry in June 2024, the Analysis also credited carriers from Asia Pacific with contributing the highest share of 40%, followed by European carriers with a 24% contribution.

Talking about the total air passenger market, IATA's Air Passenger Market Analysis (June 2024) reported a 9.1% growth year-on-year for industry total RPK in June 2024 as against 8.5% growth in Available Seat-Kilometer (ASK). Regarding the total market outlook for the period, the APAC region posted the highest percentage point of 31.7, followed by the European region with 27.1%, albeit Europe performed better than APAC in terms of international air passenger market with 23.6 percentage points as against APAC's 14.7%. In relation to the global air transport outlook, the APAC region, according to IATA's Global Outlook for Air Transport (June 2024), accounted for the highest percentage change of 17% in passenger traffic (measured in RPK) and the highest percentage change of 14% in passenger capacity (measured in ASK) compared to year 2023. The IATA report identified the growth in the domestic markets of China, Japan and Australia as responsible for the RPK growth seen.

INDIA: SETTING THE PACE

India is making efforts on all levels to cement its aspirations in relation to becoming APAC's aviation hub.

"The growth in air traffic, driven by economic development and the rise of low-cost carriers (LCCs), has led to increased demand for efficient air traffic management. India is working on enhancing its airspace capacity through modernization and expansion projects," Balasubramanian explains. "India is actively modernizing its CNS/ATM systems, focusing on advanced technologies to improve airspace management and operational efficiency. The country is investing in surveillance systems, satellite-based navigation, and communication infrastructure to enhance airspace management and improve efficiency."

"GAGAN (GPS Aided Geo Augmented Navigation) system, developed by India, is a regional satellite-based augmentation system that enhances the accuracy and reliability of GPS navigation for aviation in the region. India's Regional Connectivity Scheme (UDAN) aims to enhance regional connectivity by making air travel more affordable and accessible, thus contributing to overall operational efficiency," Balasubramanian adds.

India's developmental efforts are notably multi-dimensional, according to Balasubramanian, targeting various aspects of aviation operations from personnel training to massive upgrade of infrastructure.

Senthilvel Balasubramanian, IFATSEA Asia Pacific Regional Director.

"India is investing in the training and certification or licensing of air traffic controllers, and ATSEP to ensure high safety standards. India has also successfully developed specialized maintenance units across the country for module and component level servicing of CNS equipment to ensure operational- and cost-efficiency," Balasubramanian observes. "Enhanced security measures are in place at Indian airports, including advanced screening technologies, biometric systems, and strict access controls. India is also working on improving cybersecurity measures to protect aviation infrastructure from cyber threats."

AN EYE ON OPERATIONAL EFFICIENCY

Industry reports have been reporting upbeat developments in terms of operational efficiency. For example, the newly-launched SITA Baggage IT Insights 2024 reports an improvement in the air transport industry's baggage mishandling rate in spite of the continuing spike in passenger traffic. According to the SITA report, the number of mishandled bags fell from 7.6 to 6.9 per 1,000 passengers in 2023, representing a 63% drop in mishandling rate from 2007 to 2023 and underscoring the positive impact of digitalisaion technology on the baggage handling process.

The SITA Baggage IT Insights report pegs the long term baggage mishandling rate in the APAC region at 3.1 per 1,000 bags in 2007 and 3.0 in 2023, representing, according to the report, the best rate globally in terms of mishandled baggage. Comparatively, the report shows that the European region experienced the biggest long-term drop globally in baggage mishandling rate from 16.6 per 1,000 bags in 2007 to 10.6 in 2023.

LOOKING AHEAD

Thanks to the growing digitalisation, automation and virtualisation of operations in the global aviation ecosystem, opportunities are growing in all sectors of the industry, requiring industry stakeholders to take concrete steps to up their games while leveraging the increasing affordances of technological innovations. The APAC region, from all indications, appears upbeat about cashing in on these growing opportunities. ■

UWE SCHINDLER:
A Vision of a Cloud-Based CNS/ATM Working Environment for Germany

Uwe Schindler is a German air traffic safety electronics professional (ATSEP), a licensed aviation professional and a thorough-bred aviator with an uncommon vision for the continuing modernization of aviation operations using innovative technologies. Aside from his role as an Executive in the Technical Section of GdF – the German Air Navigation Services Trade Union – Uwe has been chairing, for quite some time now and with an uncommon passion for excellence, the ATSEP Competence Sub-Committee of the International Federation of Air Traffic Safety Electronics Associations (IFATSEA). The Managing Editor of *Air Traffic Safety Electronics International*, Adeyinka Olumuyiwa Osunwusi, PhD, caught up with Uwe recently and here's what he had to say on a wide variety of issues, including the German Air Navigation Services Provider's (DFS) choice of cloud technologies for the German CNS/ATM space:

How would you describe the global aviation ecosystem today, specifically from the standpoint of the global air navigation services provision landscape?

These days, several challenges are emerging for ANSPs, driven by many-fold transformational processes and technologies, for example, the introduction of cloud-technology and -service based approaches, 4D trajectory calculation, artificial intelligence (AI), high demand of interoperability, growing air traffic and the additional cost pressure.

And what would you say regarding the German CNS/ATM environment today in terms of techno-operational metrics and infrastructure?

The pressure to rapidly enhance the CNS/ATM technologies urges ANSPs to follow the transformation to a new cloud-based environment in Germany and probably anywhere. It would be a big mistake and would drive a wrong development not to consider the importance of the inclusion of air traffic safety electronics personnel (ATSEP) during this process with respect to not getting appropriate training and competence, and not having the background of ANS during cloud-development.

Still talking about the global air navigation services terrain, what are some of the dynamic changes you are seeing today in relation to regulations, operations, infrastructures and safety?

As I have already stated, the transformation to a new cloud- and service-based environment for ANS in Germany is a big issue nowadays. Finally, though, we have made it to include ATSEP in this transformation.

In terms of regulation, the "big one" in Europe was already done in 2020 as the authorization of ATSEP became mandatory for all EU states, which is quite close to an ATSEP license. For your information, in Germany we have an ATSEP license since 1993.

What strategic and policy interventions would you advise air navigation service providers (ANSPs) to make in order to

adequately and sustainably respond to these changes?

In my view there are two key aspects: Firstly, ANSPs have to make a start on the transformation to new technologies - ATM/CNS-cloud, datalink, and maybe the use of AI soon - and number two is the obligatory involvement of ATSEP know-how and experience in these changes.

You delivered an impactful presentation at the recently concluded 14th IFATSEA Africa Region Meeting in Casablanca Morocco on the subject-matter of the role of ATSEP in a cloud environment. You spoke about the German ANSP DFS' ambitious project for the modernization of the country's CNS/ATM environment using data centres and cloud technologies. Could you explain what this transformational project is all about?

Since the project's initial phase in 2018, the focus has changed and now almost the whole CNS/ATM infrastructure is planned to be affected. Additionally, there is an ATSEP license and a strong regulator in Germany and therefore it was important for our ANSP to have a common view before the talks with our regulator.

And what is the planned operational coverage of this modern CNS/ATM project?

At the beginning, there was the plain idea to transform mainly air traffic services (ATS) systems into a cloud-environment. During the project phase since 2018, the operational coverage has changed and now almost the whole CNS/ATM infrastructure is planned to be transferred to a cloud-based and service-oriented modern infrastructure with modern change- and maintenance-methods.

What we as a union cum association suggested and which, finally, our ANSP DFS is going to implement, is a so-called 'private cloud' model with at least one data center on premise and all of the cloud and its special cloud-services will be planned, maintained and commissioned by ATSEP. That was our main point, where we had to convince our ANSP. So, the ANSP is the owner of its data.

Talking about cybersecurity, does the German aviation industry currently has a framework in place for responding to cybersecurity issues?

The German state, just as any other EU country, has a mandatory framework for its "critical infrastructure" and aviation as an industry and the ANSPs are included. But, of course, the structures and processes have to be elaborated and enhanced continuously.

Still talking about DFS' adoption of cloud technologies in the German CNS/ATM environment, how affordable and cost-effective is this adoption?

If one talks about cloud/data-center infrastructures, many people think about saving money in the short run. But, this can be deceptive. You should not start your cloud project with such a purpose. Anyhow, the cloud-technology opens the opportunity for sharing infrastructure and computing power as well as the use of shared systems between countries.

And what would you say regarding issues revolving around systems interoperability, scalability, service integrity, privacy and security?

Well, in my point of view, this is one of the big future potentials of cloud-technologies. If implemented good, they have the potentials for opening opportunities for interoperability, scalability, and service integrity. The correct realization of privacy and security implementations have to be paid attention to during the whole process.

IN TERMS OF REGULATION, THE "BIG ONE" IN EUROPE WAS ALREADY DONE IN 2020 AS THE AUTHORIZATION OF ATSEP BECAME MANDATORY FOR ALL EU STATES, WHICH IS QUITE CLOSE TO AN ATSEP LICENSE.

Given the growing concerns globally regarding the increasing vulnerability of the aviation industry to unlawful and dangerous activities within the global cyberspace, are you not worried about DFS' choice of cloud technologies for the German CNS/ATM techno-operational environment?

I would say, 'Yes and no'. Of course, every technology comes with its threats and this is not different with cloud. But, it is one of our main objectives to enhance the cybersecurity in this transformation process. And many vulnerabilities are there today, so the need for improvements already exists.

IF ONE TALKS ABOUT CLOUD/DATA-CENTER INFRASTRUCTURES, MANY PEOPLE THINK ABOUT SAVING MONEY IN THE SHORT RUN.

Issues revolving around data privacy and ownership are critical in the adoption of cloud computing technologies. What cloud-based model or architecture would you rather suggest that DFS should use?

Could you please paint a picture of the roles and responsibilities of ATSEP in a cloud-based CNS/ATM environment?

In my picture, the ATSEP will be responsible for all the tasks in cloud environments: the conception, design, and ongoing development. Aside from this, hardware-handling, maintenance, commissioning and decommissioning should be part of the responsibility of the ATSEP. This overall job-profile already exists today - the so-called System Reliability Engineer (SRE).

Would you say that German ATSEPs are proficient and competent enough today to handle the twists and turns characteristic of cloud-based operational environments?

Not today, to be candid. But, we are on the way. The existing ATSEP will have to be trained to maintain cloud-based systems. But, for the cloud itself there will be new specially educated and skilled cloud-ATSEP, who have to have the very new job profile SRE as I have already stated.

Talking about issues regarding training, competence, certification, licensing and regulations, how would you describe today's German ATSEP?

As I have mentioned earlier, the license system is well implemented in Germany since 1993. It was not a big issue to integrate cloud-technology into it. Additionally, the issues of training, competence (including ongoing competence assessment) and licensing/authorization are well organized.

And what would you say about ATSEP training, certification and competence on a Europe-wide level?

Since 2020, the European level on ATSEP training, competence and authorization is quite comparable to the situation in Germany. The EU-implementing rule (EU) 2017/373 prescribes a lot of all these.

Finally, how would you describe the future of cloud computing technology adoption in the global aviation landscape?

In the best case scenario, I could imagine that a lot of neighbour countries could work together very close in a highly interoperable manner and complement each other with ANS-services/systems. The cloud can be the enabler for all that. ■

FRAMEWORKS AND STRATEGIES FOR CYBER SECURITY IN THE ANGOLAN CIVIL AVIATION SECTOR

By Ivani Valente

In an era where technology permeates every facet of our lives, the aviation industry stands out as a prime example of innovation. From streamlined booking processes to cutting-edge aircraft navigation systems, technology has revolutionized air travel, making it more efficient and accessible than ever before. However, with these advancements comes the omnipresent threat of cyber-attacks, a concern that has garnered increasing attention in recent years.

THE SIGNIFICANCE OF CYBER SECURITY IN AVIATION

Cyber security in aviation is not merely a matter of protecting data; it's a critical component in ensuring the safety and integrity of air travel. The interconnected nature of aviation systems makes them vulnerable to a wide array of cyber threats, ranging from ransomware attacks targeting airlines' operational systems to malicious interference with air traffic control networks. One of the most pressing concerns is the potential for hackers to infiltrate aircraft systems, compromising their safety and functionality.

With modern planes becoming increasingly reliant on digital technologies, the risk of cyber-attacks disrupting flight operations or even causing accidents is a sobering reality. Moreover, airports and airlines store vast amounts of sensitive information, including passenger details, flight plans, and security protocols. A breach of this data not only poses a threat to individual privacy but also undermines trust in the aviation industry as a whole.

ENHANCING RESILIENCE THROUGH INTERNATIONAL COOPERATION

Given the global nature of aviation, cyber security in this sector cannot be effectively managed in isolation. Angola's efforts to bolster its aviation cybersecurity are complemented by its active participation in international aviation security forums and its adherence to ICAO guidelines. By engaging in cross-border collaboration, sharing intelligence, and participating in joint cyber defense exercises, Angola seeks to strengthen its defenses and contribute to a broader international effort to secure aviation systems worldwide.

A COMMITMENT TO A SECURE AVIATION FUTURE

The development of the Angolan Civil Aviation Cybersecurity Strategy marks a significant milestone in the country's commitment to protecting its aviation infrastructure from cyber threats. As technology continues to advance, the Angolan aviation sector's approach to cyber security will need to evolve accordingly. This includes not only protecting current systems but also anticipating and preparing for emerging threats that may arise with the advent of new technologies. In addition, cyber security plays a vital role in ensuring the safety, reliability, and integrity of the aviation industry. As technology continues to advance, so too must our efforts to protect against cyber threats. By implementing the Angolan Civil Aviation Cybersecurity Strategy (ACACS), Angola's aviation industry seeks to enhance its resilience and adaptability in the face of evolving cyber risks, thereby safeguarding the skies for generations to come.

THE ANGOLAN CIVIL AVIATION CYBER SECURITY FRAMEWORK

In response to these challenges, the Angolan aviation companies are currently implementing stringent cyber security measures to safeguard their systems and infrastructure. These efforts are guided by the frameworks and strategies that its CAA will publish, aimed at identifying vulnerabilities, mitigating risks, and enhancing resilience against cyber threats.

As previously hinted, the Angolan CAA is in the process of drafting the Angolan Civil Aviation Cybersecurity Strategy (ACACS) to address the evolving cyber threat landscape whose frameworks and strategies are in accordance with the ICAO's Annex 17 (its relevant provisions), the Cybersecurity Culture in Civil Aviation, Cybersecurity Strategy, Cybersecurity Policy Guidance and the Cybersecurity Action Plan documents.

With the understanding that cyber security plays a vital role in ensuring the safety, reliability, and integrity of the aviation industry and as technology continues to advance, so too must our efforts to protect against cyber threats. By implementing the Angolan Civil Aviation Cybersecurity Strategy (ACACS), what Angola strives to achieve, is the enhancement of its resilience and adaptability in the face of evolving cyber risks, while taking into account, obviously, the training needs for their cybersecurity personnel and awareness duties that have to be kept up to date, and on par with the latest technological developments. We are all well aware of the fact that no amount of structural cybersecurity implementation is enough when it comes to the neutralization or prevention of cyber-attacks and a top cyber defense strategy surpasses the publishing of documents.

However, the forthcoming documents will emphasize a multi-layered approach to cybersecurity, focusing on enhancing awareness, fostering a culture of security, and developing robust response mechanisms. The strategy will involve close collaboration with various stakeholders, including airlines, airport operators, and technology providers, to ensure that all facets of the aviation ecosystem (including international) are adequately protected. Additionally, and as previously stated, the Angolan Civil Aviation Cybersecurity Strategy aims to build capacity within the sector by offering training and resources to personnel, thereby equipping them with the skills needed to recognize and respond to cyber threats effectively".[5] ■

IVANI VALENTE IS AN ATSEP AND THE HEAD OF CYBERSECURITY AT THE ANGOLAN AIR NAVIGATION SERVICE PROVIDER (ANSP), ENNA-EP. HE IS ALSO THE CEO OF ANGOAVIAÇÃO AND THE HOST OF PODCAST RADIO ANGOAVIAÇÃO.

Editor's Note: The opinions expressed in this article are solely those of the author and do not express the views or opinions of his employer.

EVENTS

JULY 2024		
02-03/07/2024	**IATA Wings of Change Focus Africa.**	Johannesburg, South Africa.
	www.iata.org/en/events/all/focus-africa/	
02-04/07/2024	**34th ACI Europe Annual Congress and General Assembly 2024.** *Hosted by iGA Istanbul Airport.*	Istanbul, Tűrkiye.
	https://www.aci-europe-events.org	
08-11/07/2024	**CANSO Asia Pacific Conference 2024.** *Hosted by Air Traffic Management Bureau (ATMB), CAAC.*	Chengdu, China.
	https://canso.org/event/canso-asia-pacific-conference-2024/	
22-26/07/2024	**Farnborough International Airshow 2024.**	Farnborough, U.K.
	https://www.farnboroughairshow.com/fia-2024/	
AUGUST/SEPTEMBER 2024		
13-15/08/2024	**Asia Pacific Summit for Aviation Safety (AP-SAS 2024).** *Theme: "Shaping Safety Excellence: A Human-focused Approach". Venue: Beijing International Hotel, Beijing.*	Beijing, China.
	https://flightsafety.swoogo.com/ap-sas-2024	
26/08-06/09/2024	**14th Air Navigation Conference (AN-CONF/14).** *Theme: "Performance Improvement Driving Sustainability". Venue: ICAO Headquarters.*	Montreal, Canada.
	www.icao.int/meetings/anconf14/Pages/default.aspx	
07-10/09/2024	**2024 ACI-North America Annual Conference and Exhibition.** *Devos Place, Grand Rapids, MI.*	Grand Rapids, MI, USA.
	https://airportscouncil.org/conference/2024-annual-conference-and-exhibition/	
09-12/09/2024	**First Advanced Air Mobility Symposium (AAM 2024).** *Theme: "Advanced Air Mobility (AAM) Global Harmonization and Interoperability: Challenges and Opportunities". Venue: ICAO Headquarters, Montreal, Canada.*	Montreal, Canada.
	www.icao.int/Meetings/AAM2024/Pages/default.aspx	
13-16/09/2024	**International Broadcasting Conference 2024 (IBC 2024).**	Amsterdam.
	https://show.ibc.org	
16-22/09/2024	**33rd ACI Africa Annual General Assembly, Regional Conference and Exhibition.**	Johannesburg, South Africa.
	https://aciafrica.zohobackstage.eu/joburg	
23-26/09/2024	**Customer Experience Summit and Exhibition 2024.** *Hosted by Hartsfield-Jackson Atlanta International Airport.*	Atlanta, U.S.A.
	https://aci.aero/events/customer-experience-summit-and-exhibition/	
24-25/09/2024	**World Sustainability Symposium (WSS).**	Miami, U.S.A.
	www.iata.org/en/events/all/world-sustainability-symposium/#tab-1	
OCTOBER/NOVEMBER 2024		
01-03/10/2024	**World Safety and Operations Conference (WSOC).**	Marrakech, Morocco.
	www.iata.org/en/events/all/wsoc/	
01-04/10/2024	**CANSO Africa Conference 2024.** *Theme: "Focus on Implementation". Hosted by: Empresa Nacional de Aeroporto e Segurança Aerea (ASA).*	Sal, Cape Verde.
	https://canso.org/event/canso-africa-conference-2024/	
07-10/10/2024	**2024 ACI-North America PS&S/ACC Security Technology Conference.** *Venue: Renaissance Arlington Capital View Hotel, Arlington, VA.*	Arlington, VA, USA.
	https://airportscouncil.org/conference/2024-aci-na-pss-acc-security-technology-conference/	
14/10/2024	**Fifth Global Standards Symposium (GSS-24).** *Theme: Charting the Next Digital Wave: Emerging Technologies, Innovation, and International Standards.*	New Delhi, India.
	https://gss.itu.int	
15-24/10/2024	**World Telecommunication Standardization Assembly (WTSA-24).**	New Delhi, India.
	www.itu.int/wtsa/2024/	
20-24/10/2024	**52nd IFATSEA General Assembly.** *Theme: "Deal Us In! ATSEP, Key Contributors to a Global Seamless Airspace." Venue: The LINQ Las Vegas Hotel, 3535 Las Vegas Boulevard South, NV 89109.*	Las Vegas, Nevada, USA.
	https://www.ifatsea52ga.org	
30-31/10/2024	**EASA's Annual Safety Conference 2024.** *Theme: "Safety – technology – and the human dimension".*	Budapest, Hungary.
	https://www.easa.europa.eu/en/newsroom-and-events/events/easa-annual-safety-conference-2024	
05-06/11/2024	**The Trinity Forum 2024.** *Hosted by Airports Corporation of Vietnam (ACV) and Imex Pan Pacific Group (IPPG).*	Ho Chi Minh City, Vietnam.
	https://trinityforum.events	
05-07/11/2024	**77th Annual International Aviation Safety Summit (IASS24).** *Venue: Grand Hyatt Rio de Janeiro.*	Rio de Janeiro, Brazil.
	https://flightsafety.swoogo.com/IASS2024	
13-15/11/2024	**19th ICAO Traveller Identification Programme (TRIP) Symposium.** *Venue: ICAO Headquarters, Montreal.*	Montreal, Canada.
	www.icao.int/Meetings/TRIP-Symposium-2024/Pages/default.aspx	
19-20/11/2024	**Wings of Change Europe (WoCE).**	Rome, Italy.
	www.iata.org/en/events/all/wings-europe/	
26-28/11/2024	**Airports Innovate 2024.** *Hosted by Aeroporti di Roma.*	Rome, Italy.
	https://aci.aero/events/airports-innovate-2024/; www.miceconciergeme.com/airportsinnovate2024/registration/Site/Register	
26-28/11/2024	**3rd Civil Aviation Legal Advisers Forum (CALAF/3).** *Venue: Royal Aeronautical Society, 4 Hamilton Place, London.*	London, U.K.
	www.icao.int/Meetings/CALAF3/Pages/default.aspx	
DECEMBER 2024		
02-03/12/2024	**Wings of Change Middle East (WoCME).**	Riyadh, Saudi Arabia.
	www.iata.org/en/events/all/wings-of-change-middle-east/	
MAY 2025		
13-15/05/2025	**Airspace World 2025.**	Lisbon, Portugal.
	https://airspaceworld.com	

CALENDAR

TRAINING & DEVELOPMENT

JULY 2024		
FLEXIBLE	**Air Traffic Safety Electronics Personnel (ATSEP) Basic (Online).** *Institution: Nigerian College of Aviation Technology (NCAT), Zaria, Nigeria.*	Nigeria (Online).
	https://igat.icao.int/ated/TrainingCatalogue/Course/2472	
08-12/07/2024	**ATSEP Competency Assessor (ATSEPCA) Course.** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/course-calendar/atsep-competency-assessor-atsepca-course-new	
15-26/07/2024	**Advanced NAVAIDS Training (Simulator-based).** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/course-calendar/advanced-navaids-training-simulator-based	
17-24/07/2024	**Aviation Foundation Programme** – Under the Singapore-ICAO Developing Countries Fellowship Training Programme 2024/2025. *Institution: Singapore Aviation Academy.*	Singapore
	www.caas.gov.sg/saa/fellowships; www.caas.gov.sg/saa/saa-programmes	
AUGUST/SEPTEMBER 2024		
12-16/08/2024	**Aviation Crisis Management** – Under the Fellowships for African Civil Aviation Commission Member States. *Institution: Singapore Aviation Academy.*	Singapore.
	www.caas.gov.sg/docs/default-source/docs---saa/afcac-terms-of-award.pdf	
19/08-06/09/2024	**VSAT Training (Classroom).** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/course-calendar/vsat-training	
19/08-06/09/2024	**ATSEP Basic Course.** *Institution: Skyguide Academy, Wangen.*	Switzerland.
	https://dfs.de/homepage/de/services/training/dfs-sg-atsep-training-schedule-221222-v2.pdf?cid=i4m	
26/08-01/11/2024	**ATSEP Phase I Course.** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.dfs.de/homepage/en/services/training/	
SEPTEMBER/OCTOBER 2024		
09-27/09/2024	**ATSEP Qualification Navigation.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	https://dfs.de/homepage/de/services/training/dfs-sg-atsep-training-schedule-221222-v2.pdf?cid=i4m	
17-20/09/2024	**ATSEP Qualification – Shared.** *Institution: Entry Point North.*	Sweden.
	www.entrypointnorth.com/services/atsep-qualification-shared/	
07-25/10/2024	**ATSEP Qualification – Surveillance.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	www.dfs.de/homepage/en/services/training/	
23/09-02/10/2024	**ATSEP Qualification SMC Combined (Virtual Classroom).** *Institution: Entry Point North.*	Sweden.
	www.entrypointnorth.com/services/atsep-qualification-smc-combined/	
FLEXIBLE	**Air Traffic Safety Electronics Personnel (ATSEP) Basic (Online).** *Institution: Nigerian College of Aviation Technology (NCAT), Zaria, Nigeria.*	Nigeria (Online).
	https://igat.icao.int/ated/TrainingCatalogue/Course/2472	
OCTOBER/NOVEMBER 2024		
07-25/10/2024	**ATSEP Qualification - Surveillance.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	www.dfs.de/homepage/en/services/training/	
14-25/10/2024	**ATSEP Qualification NAV Combined (Virtual Classroom)**	Sweden.
	www.entrypointnorth.com/services/atsep-qualification-nav-combined/	
14-18/10/2024	**Safety Management System Implementation** – Under the Fellowships for African Civil Aviation Commission Member States. *Institution: Singapore Aviation Academy.*	Singapore
	www.caas.gov.sg/saa/fellowships	
21-25/10/2024	**Advanced Safety Management System (SMS) in Aviation (Classroom).** *Institution/Venue: ACCET Accredited IATA Training Center, 703 Waterford Way, NW 62nd Avenue, Miami, Florida.*	Florida, USA.
	www.iata.org/en/training/courses/sms-advanced/tcvg30/en/	
22-30/10/2024	**Air Navigation Services Inspector – CNS Course.** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/course-calendar/air-navigation-services-inspector-communication-navigation-surveillance	
28/10-08/11/2024	**Executive Civil Aviation Management.** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/index.php/course-calendar/executive-civil-aviation-management-1	
28/10-08/11/2024	**ATSEP Qualification – System Monitoring and Control.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	www.dfs.de/homepage/en/services/training/	
NOVEMBER/DECEMBER 2024		
11-20/11/2024	**ATSEP Qualification - Shared.** *Institution: Skyguide Academy, Wangen.*	Switzerland.
	https://dfs.de/homepage/de/services/training/dfs-sg-atsep-training-schedule-221222-v2.pdf?cid=i4m	
13-22/11/2024	**ATSEP Qualification COM Combined (Virtual Classroom)**	
	www.entrypointnorth.com/services/atsep-qualification-com-combined/	
FLEXIBLE	**Air Traffic Safety Electronics Personnel (ATSEP) Basic (Online).** *Institution: Nigerian College of Aviation Technology (NCAT), Zaria, Nigeria.*	Nigeria (Online).
	https://igat.icao.int/ated/TrainingCatalogue/Course/2472	
11-29/11/2024	**ATSEP Basic Course.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	https://dfs.de/homepage/de/services/training/dfs-sg-atsep-training-schedule-221222-v2.pdf?cid=i4m	
11/11-06/12/2024	**DME Maintenance.** *Institution: East African School of Aviation (EASA), Embakasi Campus.*	Nairobi, Kenya.
	www.easa.ac.ke/ course-calendar/dme-maintenance	
25/11-06/12/2024	**ATSEP Qualification SUR Combined (Virtual Classroom)**	
	www.entrypointnorth.com/services/atsep-qualification-sur-combined/	
02-11/12/2024	**ATSEP Qualification – Shared.** *Institution: DFS Air Navigation Services Academy, Langen.*	Germany.
	https://dfs.de/homepage/de/services/training/dfs-sg-atsep-training-schedule-221222-v2.pdf?cid=i4m	

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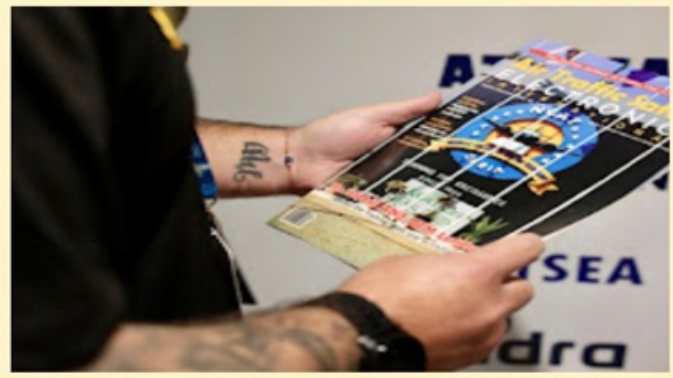

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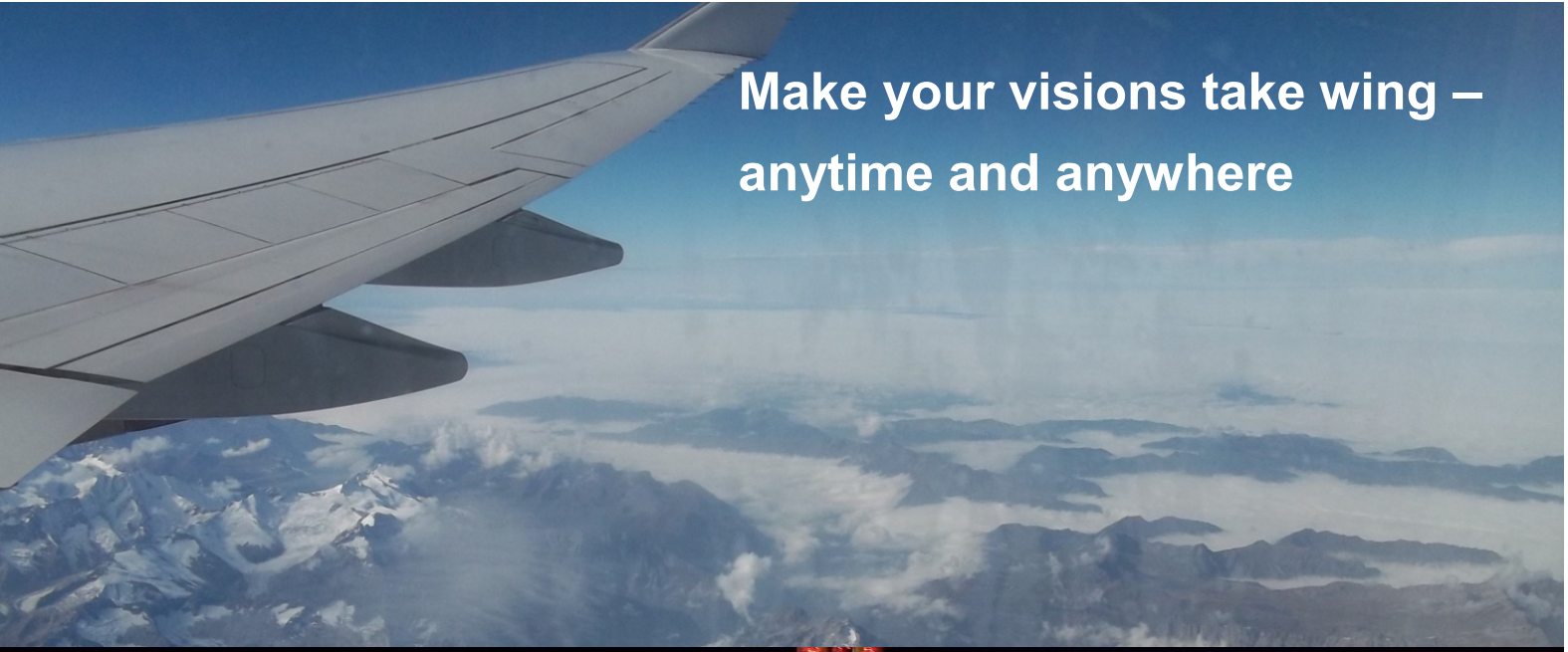

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