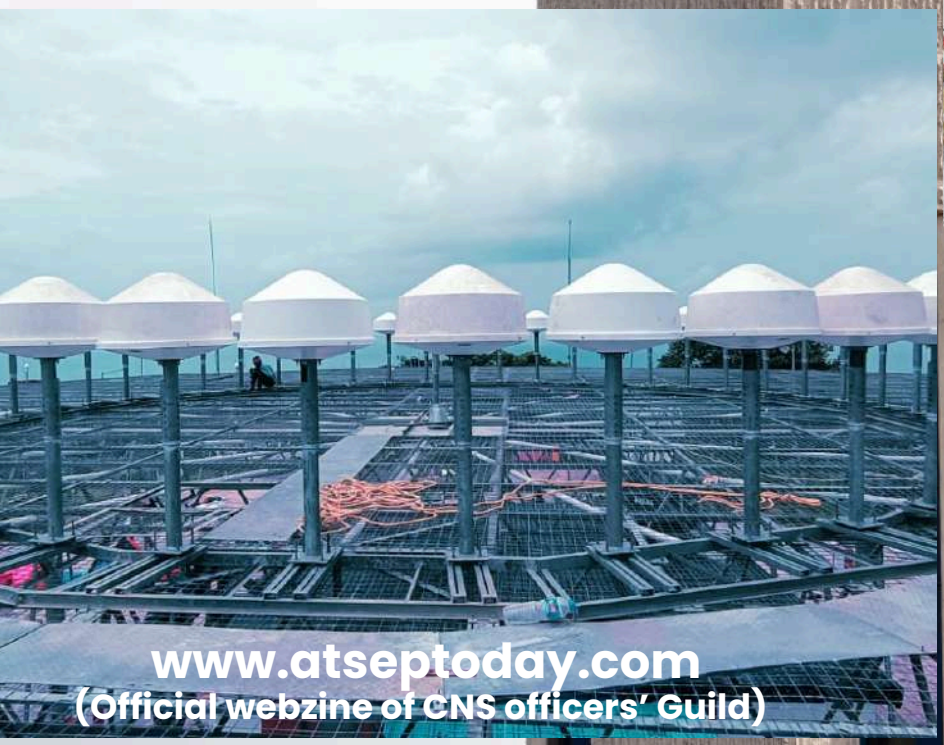
International ATSEP day
2024 Edition

ATSEP today



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CNS Officers' Guild, India

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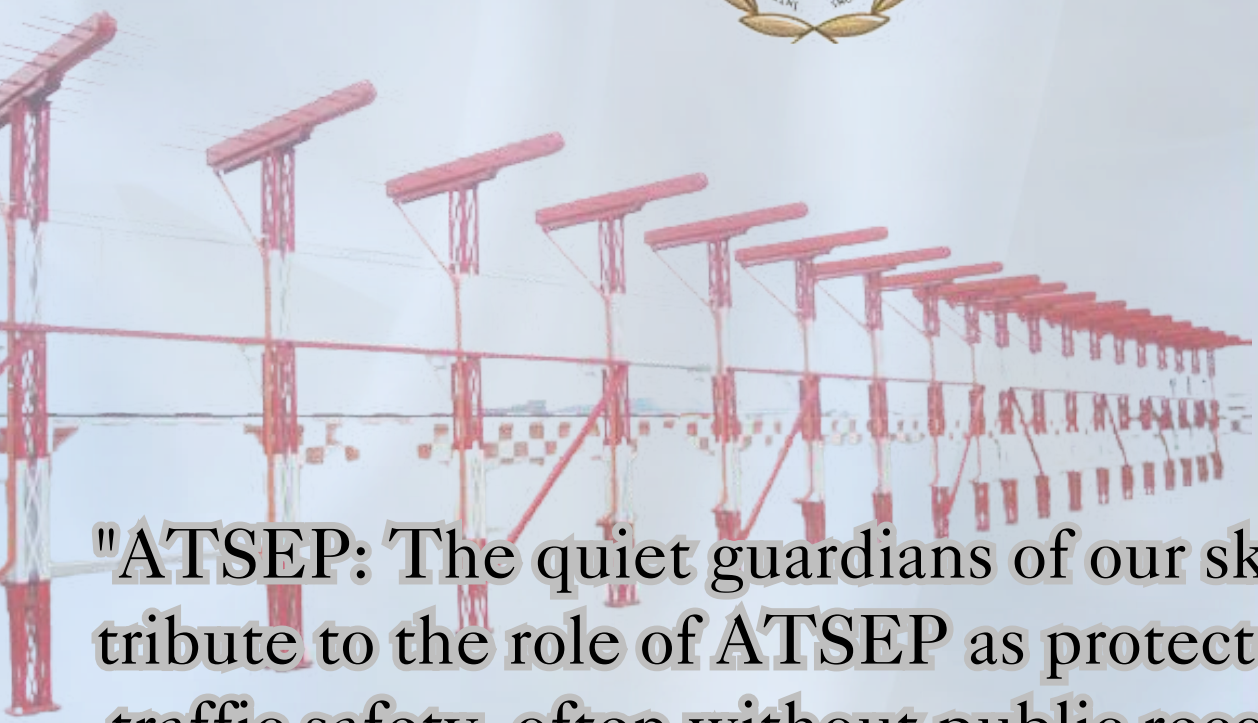

"ATSEP: The quiet guardians of our skies." – A tribute to the role of ATSEP as protectors of air traffic safety, often without public recognition.

ATSEP Day is a moment to recognize the critical role each of you plays in maintaining the safety, reliability, and innovation of air navigation services. Your commitment to excellence, even in challenging circumstances, is an inspiration to all. As technology advances and the aviation landscape evolves, your work continues to adapt and meet the demands of the future.

Thank you for your unwavering commitment, technical expertise, and passion for excellence. Let us continue to work together in strengthening our profession and advancing safety standards in the skies.

Happy ATSEP Day!

वुमलुनमांग वुअलनाम, भा.प्र.से.
Vumlunmang Vualnam, IAS

सत्यमेव जयते

सचिव
नागर विमानन् मंत्रालय
भारत सरकार
नई दिल्ली-110 003
SECRETARY
MINISTRY OF CIVIL AVIATION
GOVERNMENT OF INDIA
NEW DELHI-110 003

Dated: 7th November, 2024

MESSAGE

On behalf of the Ministry of Civil Aviation, I extend my warmest greetings and sincere appreciation to all Air Traffic Safety Electronics Personnel (ATSEP) as we celebrate International ATSEP Day. This occasion serves as a recognition of your invaluable contributions to the safety, efficiency, and technological advancement of our nation's air traffic systems.

As the aviation industry evolves with new technologies, your work becomes even more crucial. The Ministry is committed to supporting ATSEP professionals in advancing their skills and adapting to the demands of modern air traffic management. We recognize that the future of aviation rests on the capabilities and knowledge you bring to your roles each day.

On this special day, we honor your hard work and dedication, which often occurs behind the scenes but is felt by all who depend on safe and reliable air travel. Thank you for your steadfast commitment to excellence and for upholding the highest standards in aviation safety.

Wishing you all a memorable and inspiring International ATSEP Day.

(V. Vualnam)

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राजीव गांधी भवन
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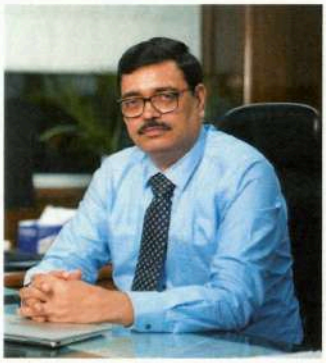

Dear ATSEP Colleagues,

As we gather to mark International ATSEP Day, I am honoured to extend my heartfelt gratitude and admiration for your dedicated service and unwavering commitment to ensuring the safety and efficiency of our airspace. The work of Air Traffic Safety Electronics Personnel (ATSEP) often goes unseen by the public, yet it is the foundation that supports every successful flight and the safe journey of millions of passengers.

This day provides us a moment to reflect on the critical role that ATSEP play in managing, maintaining, and advancing the complex infrastructure that drives our aviation systems. Your expertise, from maintaining vital navigation aids to ensuring the seamless functionality of radar and communication systems, represents an essential pillar of aviation safety. The efforts you invest — sometimes under challenging conditions and always with precision and dedication — are instrumental to the operational excellence of airports across our nation and the world.

In an era of rapid technological advancement, I recognize the need for continuous support, skill enhancement, and innovative solutions. We are committed to backing you with the resources and training necessary to meet the demands of evolving technology. Together, let us continue to build a robust, resilient, and future-ready air traffic management system, making air travel safer and more efficient.

I wish you all a meaningful and inspiring International ATSEP Day.

08/11/2024.

(Vipin Kumar)

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Dear ATSEP Team,

As we celebrate International ATSEP Day on November 12th, it is my privilege to acknowledge the critical role each of you plays as Air Traffic Safety Electronics Personnel (ATSEP) within our air navigation framework. Today, we honour your technical expertise, commitment, and tireless dedication to ensuring the safety, efficiency, and reliability of our air traffic management systems.

Air Navigation Services are at the heart of a safe and efficient aviation sector. They encompass all the essential functions required for managing the safe movement of aircraft in our skies—from air traffic control and navigation to communication and surveillance.

Your work behind the scenes—monitoring and enhancing the critical systems that allow for accurate, real-time communication between pilots and controllers—ensures that millions of passengers reach their destinations safely and on time. You are truly the guardians of the skies, and your role is indispensable to the integrity of the aviation sector.

May this International ATSEP Day inspire us all to continue working together toward an even safer and more efficient future for air navigation services.

With respect and appreciation,

(M SURESH)

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SPECIAL EDITION ON INTERNATIONAL ATSEP DAY 2024

From Editor's Desk

Vineet Gera,
Jt GM (CNS), AAI, CATC

Welcome to the November 2024 edition of ATSEP Today.

In the past two decades, we all are witness to upswing experienced by Indian aviation sector. The transformation has been significant, from conventional buildings to impressive glass made fancy terminal building structures, world class passenger facilities, state of art CNS equipment, use of satellite as an aid to improve navigation, upgraded ATC Surveillance, ADS-B as dependable and low cost surveillance system, fully integrated flight and surveillance data processing systems, gradual shift to performance based navigation (PBN), space-based ADS-B, etc.; the list is pretty long. The storyline will be incomplete if I don't mention the name i.e. Captain Gopinath, who, in early 2000, made air travel popular among millions of Indians with its budget airline concept. The growth has been further fueled by ambitious plans of Government of India by introducing new aviation policy framework, RCS and UDAN schemes.

About the Editor

Mr. Vineet Gera joined Airports Authority of India as Manager (Electronics) in 1996. During this long association with AAI Mr. Gera has worked in different capacities for the operation and maintenance of navigation and surveillance systems. His main exposure has been in the field of satellite based navigation. Mr. Gera was part of GAGAN implementation team, right from it's inception in 2002, till commissioning in 2015. He has also worked as Project Manager for the planning and implementation of first GBAS Pilot project at Chennai. During his tenure at Ahmedabad (2018 – 2024) Mr. Vineet Gera was instrumental in establishing GNSS Research Center for Ionospheric Studies and Navigation Application at Ahmedabad airport.
Currently Mr. Gera is working as faculty at Civil Aviation Training College, AAI, Prayagraj.

Of all the technological developments in aviation field, GNSS has been the outperformer. And GPS being the forerunner has always been the most used and popular candidate, however over time other GNSS constellations viz. GLONASS, BeiDou, GALILEO too geared up. This position, navigation and timing (PNT) based solution is being successfully used in various countries to serve all phases of flight, down to CAT-I. More sophisticated application of GNSS i.e. to support CAT-II/III are under various stage of experimentation / validation. Due to involvement of external factors, ionospheric error as the most dominant one, GNSS performance in equatorial region has been challenging especially during the most critical phase of flight. Entry of DFMC (Dual Frequency and Multiple Constellation) based systems in GNSS landscape is certainly going to be a game changer, given the capability of computing ionospheric error at user-end itself.

Imagine a scenario where GPS signals are not available for technical reasons, physical events OR sabotaged, could be jammed or spoofed. Spoofing i.e. generating counterfeit signals and radiating the same to misguide the user is something more worrisome as carefully designed spoofed signal setup is capable enough to offshoot an aircraft from its designated route. DFMC based systems not only are capable of improving navigation performance but also serve as an alternate in case of selective jamming or spoofing. Adding encryption and authentication onto satellite navigation signals is another means of protecting user in case of spoofing attack. Open Service Navigation Message Authentication (OSNMA) feature on GALILEO GNSS signals assures that navigation information is coming from a trusted source and has not been modified. In days to come, similar feature will be available with other GNSS constellations too. Technological advancements always have their associated vulnerabilities and threats, either man-made or due to physical phenomenon. Space weather, with sun as its source, generates several detrimental emissions, namely solar flare, coronal mass ejection (CME), geo-magnetic storm, having enough potential to disrupt satellite operations, ending up in reduced PNT accuracy or complete loss of PNT. Several incidents of GNSS signal spoofing, witnessed by aircrafts in 2023-24 itself have raised serious safety concerns among aviation community. According to industry sources, number of flights per day affected due to spoofing increased from a few dozen in February 2024 to around 1400 in August 2024.

Considering the vulnerability of GNSS signals to natural or man-made threats and resulting into a total blackout like situation, the need for an equally efficient and reliable backup system is urgent. The testing campaign for an alternative / complementary system has already been initiated by both USA and European Commission (EC). Volpe and DEFIS (Defense Industry and Space) report from USA and EC respectively are in the process of evaluating available technologies, those can replace GNSS. Whether the potential of GNSS can be met with a single technology or amalgamation of several technologies / system, remains to be seen.

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IFATSEA elects a new Executive Board

The International Federation of Air Traffic Safety Electronics Association (IFATSEA) had its 52nd General Assembly in Las Vegas, USA elected new executive board and Ing Frank Kofi Apeagyei MBA, MS, PMP as the President of the Federation.

Ing Frank Kofi Apeagyei MBA, MS, PMP is a Ghanaian with enormous understanding of the Aviation industry and has over 10years experience on the International Executive Board.

He served two terms as Regional Director for Africa and two years as the Executive Secretary.

Ing Frank Kofi Apeagyei
President, IFATSEA

His election to the apex body is the first ever for an indigenous African. Ing Frank Kofi Apeagyei MBA, MS, PMP will lead a team of experienced and sound Officers of the Board to serve the Air Traffic Safety Electronics Engineers and the Aviation Community to strategically support its members to meet the challenges in the industry head -on.

Umesh Kumar
Regional Director-APAC

Umesh Kumar, Bachelor of Engineering (Electronics & Tele Communication) brings a wealth of experience and commitment to the role of Regional Director-APAC (IFATSEA), with a background spanning over [22 years] in air traffic safety electronics at different levels and a proven record of dedication to enhancing safety standards and advancing the profession.

ARTICLES AND OPINIONS

Disclaimer: The views and opinions expressed in the articles featured in this webzine are solely those of the authors and do not necessarily reflect the official policy or position of CNS Officers Guild / ATSEP today.

GNSS Research Centre: Advancing Ionospheric Studies and Navigation Applications

Dr Surendra Sunda
DGM (CNS), Ahmedabad Airport

The Global Navigation Satellite System (GNSS) Research Centre is at the forefront of ionospheric research, paving the way for enhanced navigation applications. Established at SVP International Airport, Ahmedabad, in year 2020, this state-of-the-art facility is dedicated to exploring the intricacies of the ionosphere and its impact on satellite navigation in line with ICAO guidelines.

Introduction

Sun is the primary source of energy needed to ionize the Earth's atmosphere, known as ionosphere, which is situated from 90 km upwards. The Sun has 11-year solar cycles where solar activity varies from low, medium to high. It is generally measured using the sunspot number as shown in Figure 1, indicating the solar cycle. Currently, the solar activity is Maximum in 2024 and expected to remain so till 2026. During this phase, the Sun emits stronger particles as well as radiation through Coronal Mass Ejections (CMEs) and solar flares causing geomagnetic storms over Earth. This directly modulates the electron density of the ionosphere.

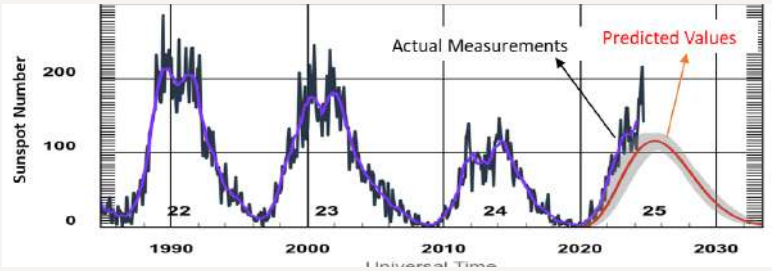


Figure 1: 11-year Solar cycle exhibiting solar minima and Maxima.

The ionosphere plays a crucial role in satellite communication and navigation. Ionospheric disturbances can significantly affect signal transmission, leading to positioning errors. Moreover, the ionospheric behavior is anomalous over the equatorial and low latitude region due to so called Equatorial Ionization Anomaly (EIA). Hence it is more dynamic and introduces large positional errors as compared to other regions of the World. The GNSS Research Centre tackles these challenges head-on.

GNSS Ionospheric Monitoring Network

In order to sense the electron density i.e. Total Electron Content (TEC) using the dual-frequency GPS receivers, AAI has established Ionospheric Monitoring Network consisting of 25 Airports (known as TEC stations) as shown in Figure 2 in collaboration with Space Application Center, ISRO, Ahmedabad. It was upgraded in 2023 with Multi-Frequency Multi-Constellation GNSS Receivers allowing the observations from all GNSS (GPS, GLONASS, GALILEO, Beidou, QZSS, IRNSS) satellites. Its objectives were to:

a. Monitor and understand the impact of Ionosphere on GNSS/GAGAN

b. Understand the morphology of scintillation over India and its impact

c. Develop/reconfigure the region specific iono model for GAGAN/GBAS

Due to dynamic nature of ionosphere which varies primarily with solar activity, the occurrence of extreme case is not ruled out in future, hence the continuous monitoring of Ionosphere is recommended by ICAO Safety Assessment document for Safety-of-life application like SBAS/GBAS.

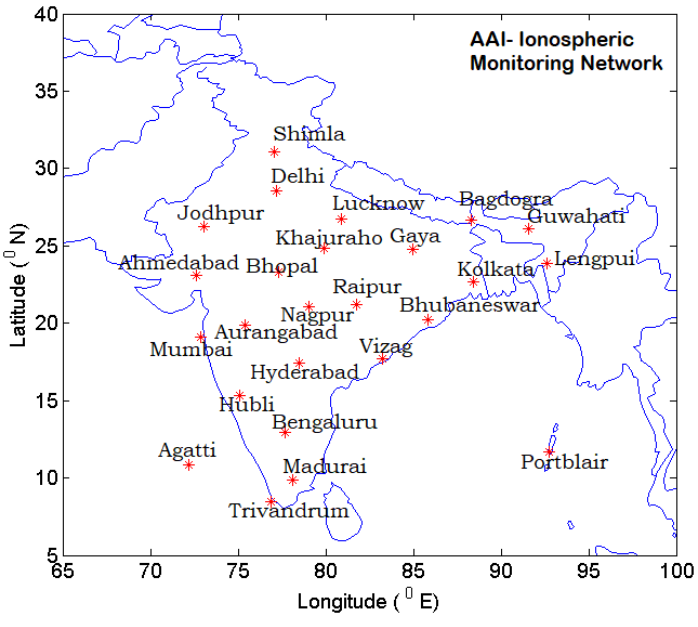


Figure 2: Location of GNSS Ionospheric Monitoring Airports

Infrastructure setup/Facilities

The GNSS Research Center, Ahmedabad is hosting the cutting-edge Data processing server and Storage facility with advanced cyber security measures.

The center houses the GNSS lab with high-end workstations, VM servers and software, 3 GNSS Receivers and Aviation grade SBAS receiver for research and experimental purposes. Data from 25 Ionospheric Monitoring stations is collected automatically through FTP on daily basis.

Scope of Work / Research Objectives

a. Design and development of a central archiving and processing facility for storing data and deriving/ presenting results and final products.

b. GAGAN Performance Analysis: Development of software tools for evaluating the GAGAN Signal-in-Space (SiS) using independent data.

c. Signal Propagation Analysis: Investigating signal distortion and delay caused by ionospheric activity.

d. Space Weather Monitoring: Tracking solar activity and geomagnetic storms impacting navigation.

e. Development of region-specific ionospheric threat model for GBAS

f. Study the implications of proposed upgrade in SBAS to Dual Frequency Multi- Constellation (DFMC) in the equatorial and low latitude region.

g. Data sharing with academia and research institutes having similar interest.

Outcomes

1. Software tools: Various Software have been developed in MATLAB, C++ and Python programming languages. Some of them are listed below:

a. TEC Computation Tool – to estimate TEC from Receiver Independent Exchange (RINEX) Format, which is a data interchange format for raw GNSS observations.

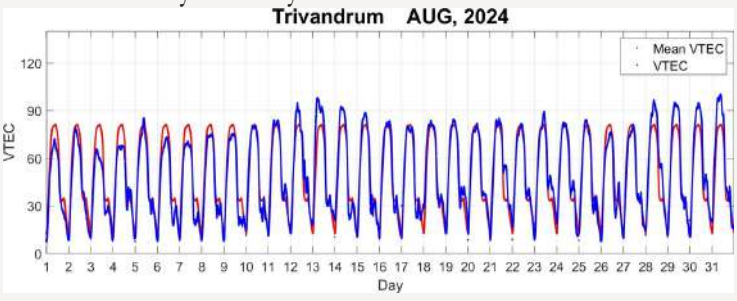
b. Ionosphere Data Analysis and Monitoring Tool suite – to generate different graphs and time series plots of TEC, Scintillation, GEO Signal, Position, Grid Ionospheric Vertical Delay broadcast by GAGAN etc.

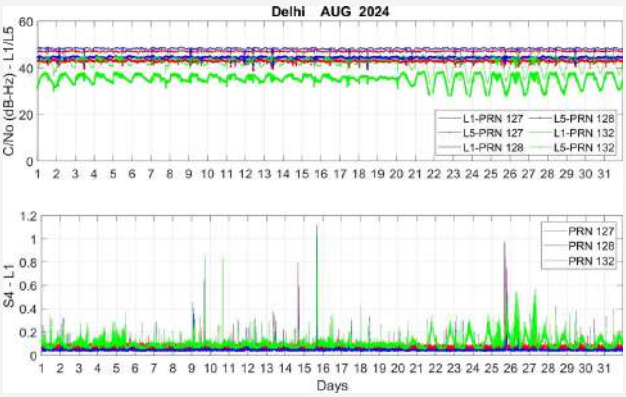
c. Multipath Estimation tool – to estimate the multipath error using dual-frequency GNSS measurements (RINEX data).

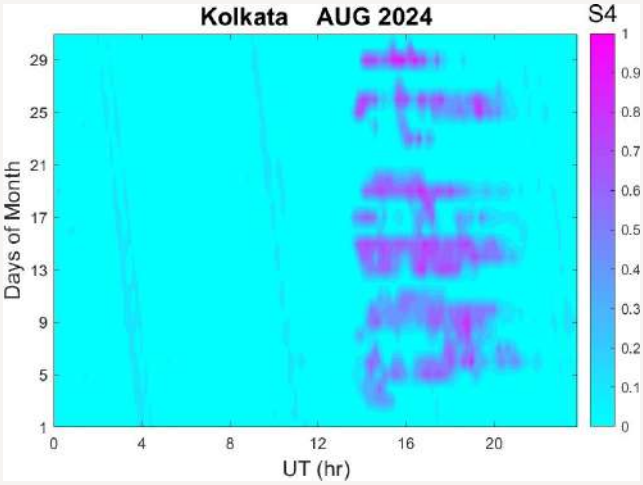
d. HPL/VPL Computation tool- Horizontal and Vertical Protection Limits are computed akin to the aviation receiver using GAGAN SiS and GPS Almanac/Ephemerides. Useful in determining the availability of GAGAN service at any given location/area.

2. Technical Reports: are generated on research work involving case studies and long-term data analysis of TEC and Scintillation with solar cycle, space weather events etc. Information and Working papers on research work are also presented in ICAO meetings.

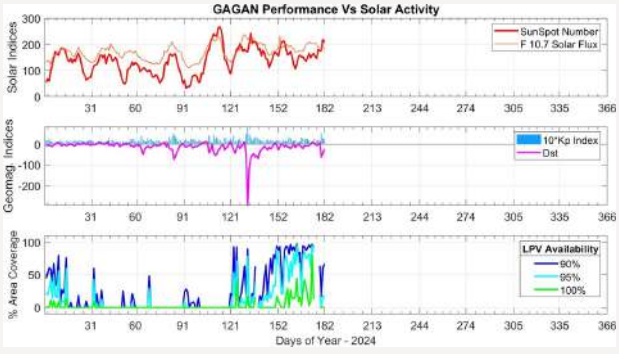
3. Monthly Reports: Monthly results of ionospheric behaviour are prepared which help in identifying the anomalies, and trends. Apart from Solar activity, the ionosphere is influenced by seasonal and local day-to-day variations.



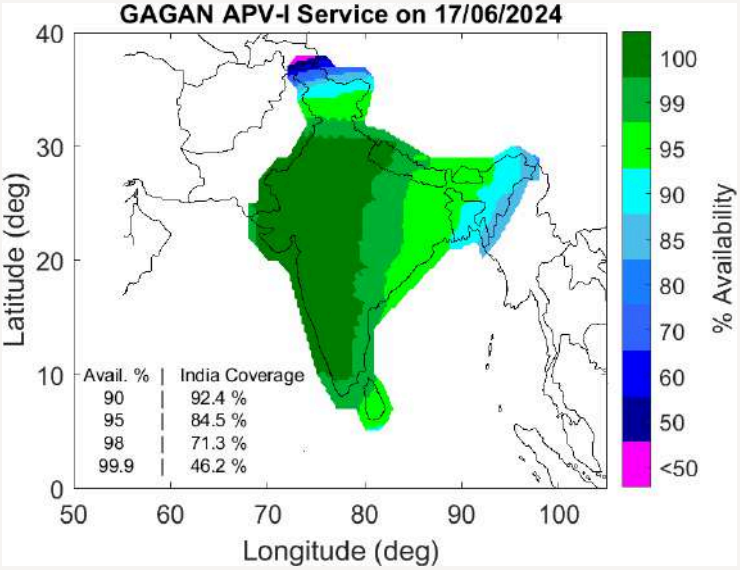


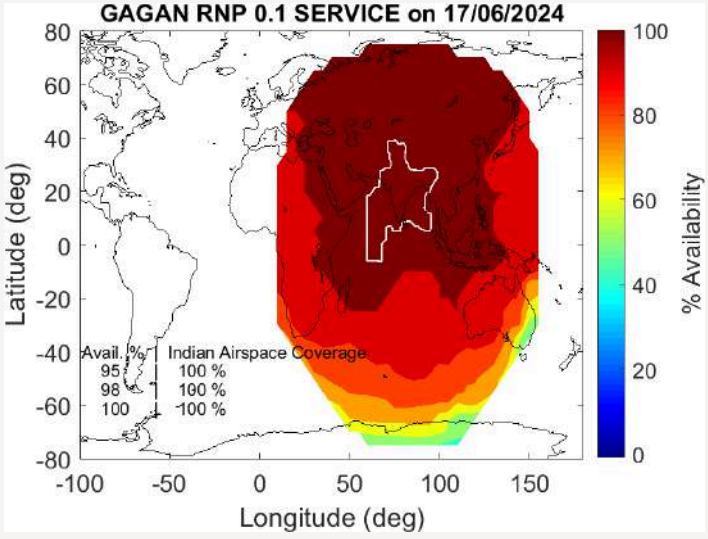


4. GAGAN Independent Performance Analysis: The GAGAN SiS performance is evaluated in terms of Accuracy, Integrity and Availability using the independent data sources and independent tools developed in-house.



5. Website for Real-time Display: A website has been developed which is hosted currently on AAI Intranet providing the Real-Time results of Satellite status and Ionospheric Corrections broadcast by GAGAN GEO Satellites. It also provides previous day GAGAN Availability performance for APV-I and RNP0.1 Services (coverage from Africa to Australia) along with time series plots.





Future Directions

1. Dual-Frequency Multi-Constellation (DFMC) Support: Integrating diverse GNSS systems to improve the accuracy and availability.

2. GNSS Interference Monitoring and its mitigation.

3. Artificial Intelligence Integration: Enhancing prediction accuracy.

Collaboration and Innovation

The Centre aims to work closely with academic institutions, research organizations, and industry partners to drive advancements in GNSS based navigation applications. This collaborative approach will ensure that the latest scientific insights and technological developments are integrated into practical solutions for the aviation industry.

Conclusion

The GNSS Research Centre is equipped with advanced technology to monitor and analyze ionospheric conditions and GAGAN performance in real-time. This includes the development of tools and models to predict ionospheric behavior and its impact on GNSS signals. Such research is crucial for improving the performance of Ground-Based Augmentation Systems (GBAS) and Satellite-Based Augmentation Systems (SBAS), which are essential for precision approach and landing operations in aviation. As the Centre continues to grow and evolve, it will undoubtedly play a pivotal role in shaping the future of aviation navigation in India and beyond.

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Improvements in ATC and GNSS vulnerabilities highlight the importance of the ATSEP profession

ADAPTING AIR TRAFFIC CONTROL FOR TOMORROW'S SKIES

Nikola Cojic
Treasurer, IFATSEA
Montenegro

Although it is a complex and dynamic sector, the aviation industry plays a vital role in the world economy. For example, as with other industries, financial interests drive how the sector functions; thus, efficiencies regarding safety remain critically important in conjunction with factors like route optimization and fuel management, which are ultimately tied to single-pilot operations, should that become a reality. All these changes are subject to the scrutiny of a plethora of national and international entities that are responsible for enforcing standards covering safety, security, and environmental impact — they often interfere with profit maximization. Technologically, the evolution of aviation is so rapid that ongoing innovation and adaptation are necessary to meet regulatory guidelines and to help develop more advanced aircraft, navigation systems, and digital optimization tools for safety, reliability, and passenger experience.it

More efficient tools in air traffic management, from forward-looking surveillance to data sharing platforms and automation tools will help increase airspace capacity, optimize flight paths, reduce delays while enhancing the overall safety and environmental performance. With all these developments some new risk factors are coming.

For air traffic safety electronics personnel (ATSEP), these challenges are becoming evident -

in the growing complexity of systems, new technologies intermeshed within legacy infrastructure and solutions, security vulnerabilities, as well as the anticipated integration of Remote or Virtual Towers. To effectively navigate these changes, a wide range of regulatory measures that include safety and security protocols will be needed. As such, ensuring compliance and keeping up to date with ever-changing regulations can present challenges for organizations.

Increasing digitization and automation affects the ATSEP working environment

There is an indisputable transformation occurring within the realm of ATSEP operations, precipitated by the pervasive integration of digital technologies and automation across all facets of our industry. These advancements are reshaping the landscape of preventive and corrective maintenance, calibration, and emergency equipment interventions in ways that were previously unimaginable. The era of remote management has introduced a paradigm shift, significantly altering the traditional approach to these critical tasks.

As an engineer-instructor, I am acutely aware of the imperative to cultivate an environment that is conducive to the seamless adaptation of ATSEP personnel to these evolving requirements. The nature of our work necessitates a heightened level of vigilance and responsiveness, especially in the face of unforeseen scenarios that are an inherent aspect of our domain. The training regimen for ATSEPs must be meticulously tailored to address the multifaceted challenges that arise from this dynamic operational setting.

Luxury and sustainability can go hand in hand. This section highlights luxury hotels that prioritize eco-friendly practices without compromising on comfort and style

The invisibility of stress and fatigue in our line of work is a concern that warrants our attention. Given the high-stakes nature of our responsibilities, particularly when aircraft are airborne with passengers on board, the potential for error is significantly amplified when our staff is operating under conditions of stress or fatigue. Consequently, it is of paramount importance to implement robust training initiatives that not only enhance technical competencies but also foster an awareness and mitigation of these psychological factors.

In light of these considerations, I advocate for a comprehensive reevaluation and enhancement of our existing training protocols. This should encompass not only the honing of technical skills but also the development of procedural frameworks that are conducive to the management of stress and fatigue. By equipping our ATSEP workforce with the necessary tools to navigate this new digital ecosystem, we can ensure that their performance remains uncompromised, thus safeguarding the integrity of our air traffic control systems and the lives that depend upon them.

What IFATSEA Human factor group did in your region regarding stress and fatigue by completing the report on the study on human factors of ATSEP, which has been accepted by the ICAO office for your region, has not only resulted in significant achievements for IFATSEA and all ATSEP personnel worldwide, but it also serves as an indicator and a constant reminder to managers in the air traffic control system that this is yet another parameter that needs attention. I had the honor of being part of that group led by the exceptional Senthilvel Balasumbramanian, the IFATSEA Regional Director Asia-Pacific, and we can confidently say that this is one of the greatest achievements of IFATSEA.

ATSEPs are the first line of defense against cyber attack on the ATC systems

In many Air Navigation Service Providers (ANSPs), the predominant cybersecurity focus remains on the mitigation of financial system breaches and the acquisition of sensitive business data. This indicates a need to bolster our cybersecurity posture by enhancing the understanding of cyberspace threats among stakeholders.

Typically, in such environments, the cybersecurity narrative is framed around the enumeration of regulatory requirements, which may inadvertently instill a perception that these challenges are abstract and will manifest gradually over time. This perspective is erroneous.

ANSPs that have fully embraced IP connectivity and cloud-based frameworks must address the multifaceted realm of cybersecurity with the utmost diligence. The ramifications of potential incidents, encompassing both operational and hardware failure scenarios, necessitate meticulous integration into comprehensive contingency planning. By anticipating such events and their repercussions, these strategies bolster not only the unyielding continuity of our critical services but also their inherent reliability.

To this end, IFATSEA underscores the paramount significance of ATSEP personnel in the proactive triad of cybersecurity: forecasting potential threats, employing vigilant detection methodologies, and orchestrating robust mitigation strategies.

This approach, coupled with thorough training to navigate the evolving landscape of cyber vulnerabilities, imbues our operational frameworks with an enhanced resilience and fortitude.

The collective endeavor to educate our workforce in the nuances of this modern-day challenge ensures that our commitment to service excellence remains uncompromised, even in the face of emerging digital adversities.

This awareness is particularly pivotal for Air Traffic Safety Electronics Personnel (ATSEP), who serve as our first line of defense during the onset of a cyber incident impacting air traffic control (ATC) systems.

To effectively confront the evolving cyber threats, ATSEPs must be well-versed in the intricacies of our systems' functionality and the potential vulnerabilities they may expose. A thorough comprehension of these factors equips them with the necessary vigilance to detect anomalies and respond swiftly to emerging threats. By fostering a culture of cybersecurity awareness and preparedness, we empower these professionals to act decisively and protect the integrity of our aviation operations.

Unclear Future of GNSS use asks for Strengthening ground-based NAVAID Networks

The industry trend has been to move away from Ground-Basaed Navaids as much as possible. But, the future of GNSS use, including GPS as predominant GNSS system, became unclear. Modern aircrafts have incorporated GNSS into a large number aircraft systems and because of that GNSS problems can affect the work of weather radar, CPDLS, ADS-B, ADS-C and other avionics.

In normal operations, the aircraft GNSS receiver receives Position, Navigation and Timing from satellites. What is becoming „new normal“ for aviation is not any more to stay without GNSS signal but to have fake one! That activity, called GNSS spoofing, forces flight crew to rely more on ILS, DVOR, CVOR, DME, TACAN, combinations DME/DME and VOR/DME as well as NDB which was almost forgotten.

As we can see, any removal of enroute navaids like VOR and DME would be sensible and the only way out of this situation

is strengthening ground-based navaid networks. This places ATSEP work in a position of great importance because safety, eficiency, as well as the impact on the environment will directly depend on the maintenance on navaids and the installation of new ones.

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Recruiting and Retaining Talent: The Key to Success in the Aviation Industry

The case of Air TrafficSafety Electronics Professionals

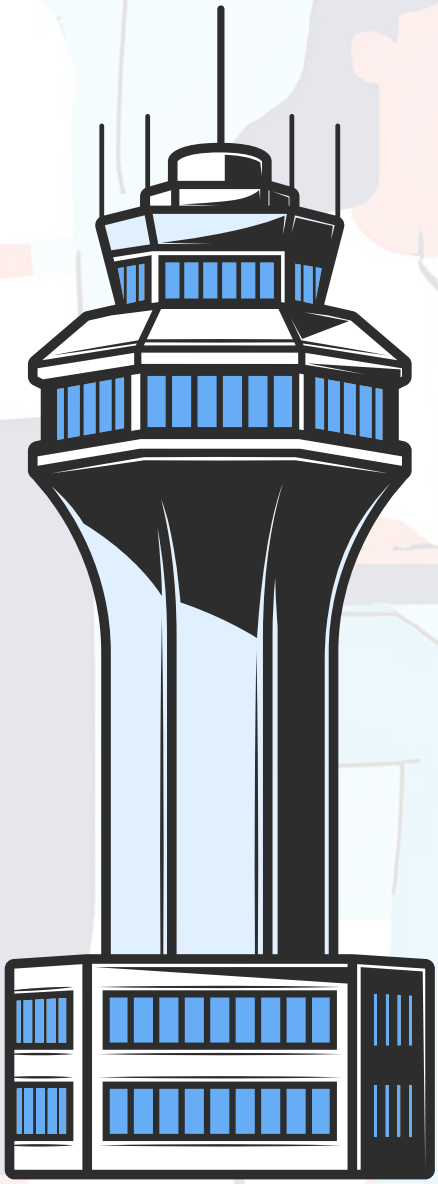
Theodore Kiritsis
Ex-President, IFATSEA
Greece

During and after the recent covid-19 crisis, the total aviation system was faced with an unprecedented economic sustainability challenge. Airlines, ANSPs and airports as well all supporting services had to maintain financial resilience and survivability in a very hostile environment. Many 'short sighted' economic measures and initiatives were invented/ one of which was to let go professionals from the related business areas.

The easy step and formula towards letting thousands of professionals with a well-established expertise did not plan, prepare or take into account the day after. A job is the way of earning a living for the worker's family budget. Of course there is job satisfaction and other elements of employee rewarding but the principal objective is financial strength to drive the family budget requirements some of which are imperative.

Having to hire new employees in place of the old-experienced ones revealed the issue of a hidden, not-originally anticipated cost that of retraining the new employees and making sure that they will be attracted for the job and after training they will be retained in the corporate entity. Issues like the learning curve of the employees as well as the time to reach maximum performance levels, similar or equivalent to those that have been laid off, have their negative impact on the related company performance index. Moreover, today, in 2023, traffic has returned back stronger and despite regional conflicts like in Ukraine, it is more demanding for more capacity, less delays, more punctuality and airport passenger flow.

All this has happened when the world and more specifically in Europe there is an effort to drive aviation towards more digitalization and automation, the renovation of the legacy CNS/ATM systems in a technologically intensive endeavor. This needed a considerable amount of funding, estimated only within SESAR of the order of magnitude of 2.5 billion Euros. Of course, deploying new CNS/ATM systems, especially in some cases of a hybrid nature, space and ground based, and integrating it with legacy ones, requires expertise, deep understanding and time resources for the technical personnel, the ATSEP, to operate, maintain and attend to them while maintaining the legacy or state of the art CNS/ATM systems and services.



Needless to say, when implementing state of the art or beyond, ATSEP are required to be trained to new technologies and concepts data and services of which will be fused with the old, existing elements of the technical and operational leg of the Total ANS. Moreover, the new architectures like the SJU Air Space Architecture study (Ref. 1) new challenges came about like Cybersecurity. Therefore, the adjustment of training in order to be able to address failure and degraded modes of distributed ANS systems and services needs to be made quickly and proactively. But that needs to shine the light onto this crucial profession elements starting from their entry qualifications with the scientific background required to serve the new technologies, their training, competency and recurrent training. This has not been done so far.

The new challenge is that as the ATSEP job complexity increases significantly, there is a new threat from other industrial areas that have significantly better and less demanding career paths as well as a lot more rewarding salaries and job appreciation offered from corporations. Establish frameworks for assessing and accrediting relevant skills and competencies, ensuring a smooth transition and facilitating career progression.

For sure also in ANS there is a need for ANSPs to apply some incentives to compromise the burden of all these requirements and give these professional the feeling that we appreciated their critical safety duties.

The best approach to this towards job recognition is the inclusion of the ATSEP Profession in ICAO Annex 1 and subsequent licensing like the Pilots, aircraft avionic engineers and ATCO. It is clear that most technical jobs, like the ATSEP one, that ensure the resilience and service continuity like the ATM environment almost never come into contact with the customer, being the passenger, the pilot or the airline and thus the job important recognition is not there. We hear of many cases when the technical staff of an ANSP never come into contact with management apart from their customary inaugural speech.

The fact that in most ANSPs technical and operational jobs, there is 24/7 rostering and the expertise attained mostly does not relate to the wider, outside aviation, industrial environment is a counterattractive element for new applicants. The fact that the ATSEP job is also connected with responsibility, even liability in some cases e.g an aviation accident/incident, is repelling to young engineers considering going for a job as an ATSEP. To add to this, there is no concern on the ATSEP career path, nor any publicity or promotion for the existence and benefits related to the profession.

This drives towards a situation where, while the European commission or ICAO are driving towards a more technology based and dependent ANS system, there will be not enough ATSEP to maintain the legacy system running, implement and deploy the new SESAR or NextGen technologies developed.

This drives towards a situation where, while the European commission or ICAO are driving towards a more technology based and dependent ANS system, there will be not enough ATSEP to maintain the legacy system running, implement and deploy the new SESAR or NextGen technologies developed. The International Federation Air Traffic Safety Electronics Associations has warned, there is already an evident lack of ATSEP in Europe as we speak. Many countries globally and especially across the European continent, are looking to hire ATSEP but they cannot find and hire them. A lot of them are doing advertising campaigns promoting the benefits of the job. One of them has had an outflux of ATSEP that were hired and trained but could not be retained due to demanding responsibilities and the unattractiveness of the job.

The poor career paths and financial compensation, salaries, were the main reasons of the shortage of those professionals. Why should a trained engineer who invested a lot of money studying up to a university or a postgraduate course in electronics or networks not choose a job in the industrial sector where the salary would be quadruple? A careful staff power planning exercise per ANSP has to be developed, . In this aspect, the retirement rate and projected times have to be integrated in the staff planning exercises so as to identify any staffing problems and proactively address their potential shortages taking into account the time to train them, their average learning curve translated into time, as well as the on the job training before they takeover full duties.

If we want to face the situation and address the problem, these issues have to be elaborated, measures and steps towards addressing them be developed, in collaboration with Professional staff organizations, employer's organizations like CANSO, regulatory establishments like ICAO and EASA.

If there is no job recognition by the ANSPs, salaries are low and no career path projected, how will a new engineer look into the ATSEP or similar job direction? If no professional esteem is generated, how and why a young scientist would look into the specific and proprietary networks in aviation which would not add specific expertise that may enable mobility for a young engineer? The best approach to this, besides the safety benefit, is the inclusion of the ATSEP Profession in ICAO Annex 1 and subsequent licensing like the Pilots, aircraft avionic engineers and ATCO.

Studies like the European study on Legal, economic and regulatory aspects of ADSPs (ATM Data Service Providers- see Ref. 1) talks about raising the level of scientific expertise requirements of the ATSEP, but at the same time talks about the economies of scale implicitly due to the reduction of ATSEP, giving a warning sign against job security which is counterproductive. The reduction of ATSEP must not be seen as a means of reducing cost but instead ,the retainment as an investment that impacts positively and sustains CNS/ATM systems and services availability and continuity that drives ANSP and even national economies and international interconnectivity. In fact, ATSEP must be part of the performance scheme in the ANSP and be rewarded for their performance. These professionals are an asset to every organization.

And last but not least, the issue of diversity must also be taken into account, as women are currently a minority in most ANSPs.

It is commendable that recently ICAO in their EURONAT area, have approached the issue of gender vigorously and starting a campaign. IFATSEA has also a Women's committee that is addressing the issue. This is also a factor of the equation on the human resources question of the present and the future.

Attracting new Air Traffic Safety Electronics Personnel (ATSEP) to the aviation industry can be challenging, given the competition from other industries. To successfully attract talent, here are some strategies and advice for constituent ANSPs and organizations in the aviation industry:

i. *Standardization of Job Requirements*: Collaborate on establishing standardized job requirements for ATSEP across the industry. Define the necessary qualifications, skills, and experience needed for different ATSEP roles. This ensures consistency and clarity in attracting talent from other industries. This standardization must be done with a vision to future requirements.

ii. *Indicate the Importance and Impact*: Emphasize the critical role ATSEP play in ensuring the safety and efficiency of air navigation systems. Highlight the impact their work has on the aviation industry and the opportunity to contribute to a vital sector that connects people and drives economic growth.

iii. *Promotion of the Profession*: Jointly promote the ATSEP profession and its benefits to professionals in other industries.

Engage in targeted marketing campaigns, organize industry events, and leverage digital platforms to create awareness about the unique opportunities and challenges that the ATSEP profession offers. Identify the counter argument towards selecting a non-safety critical job.

iv. *Competitive Compensation and Benefits*: Offer competitive salary packages and attractive benefits to make the aviation industry more appealing compared to other sectors. Conduct market research to understand industry standards and adjust compensation accordingly to attract and retain top talent. ATSEP and their management must feel that they are part of the performance of the ANSP and its success. Provide the correct incentives for such safety critical profession.

v. *Career path Development and Advancement Opportunities*: Collaborate on the development of clear and structured career paths for ATSEP. Provide clear paths for career development and advancement within the ANSP. Offer training programs, certifications, and opportunities for skill enhancement to demonstrate a commitment to the professional growth of ATSEP. Define competency frameworks and provide guidance on career progression to attract professionals looking for long-term growth and development opportunities.

vi. *Skills Recognition and Transferability*: Establish mechanisms to recognize and transfer skills from other related industries. Create pathways and support programs that enable professionals from related fields such as IT, telecommunications, or electronic engineering to transition into the ATSEP profession and leverage their existing skills and knowledge.

vii. *Technological Advancements*: Showcase the cutting-edge technologies and innovative projects that ATSEP will have the opportunity to work on. Highlight the industry's commitment to staying at the forefront of technological advancements, such as automation, artificial intelligence, and cybersecurity, to attract individuals interested in working with advanced systems.

viii. *Collaborate with Educational Institutions*: Establish partnerships with universities, technical schools, and training centers to promote the profession and offer internships or apprenticeships. Engage with students in related educational areas like technical colleges and universities early on to create awareness and attract talent to the aviation industry.

ix. *Employer Branding and Marketing*: Develop a strong employer brand that highlights the unique aspects and advantages of working in the ANSPS. Leverage social media platforms, industry events, and career fairs to showcase the organization's culture, values, and opportunities for growth. Promote scholarships during education paths as one of the ways of stimulation of interest.

x. *Work-Life Balance and Flexibility*: Recognize the importance of work-life balance as the ATSEP job is mostly 24/7 and offer flexible work arrangements when possible. Highlight initiatives such as remote work options, flexible schedules, and employee well-being programs to appeal to individuals seeking a healthy work-life integration.

xi. *Diversity and Inclusion*: Emphasize the organization's commitment to diversity and inclusion. Creatinga welcoming and inclusive work environment can attract talentfrom diverse backgrounds and enhance the industry's reputation as an inclusive and equal opportunity employer.

By implementing the above strategies and advice, constituent firms and organizations in the aviation industry can enhance their ability to attract new ATSEP and compete effectively with other industries for top talent. Creating an appealing work environment, offering competitive compensation, highlighting career development opportunities, and showcasing the industry's technological advancements and impact can all contribute to attracting and retaining skilled ATSEP professionals.

To retain current ATSEP and ensure their skills align with the needs of the 21st-century aviation industry, firms and organizations can consider the following strategies:

a. *Continuous Professional Development*: Offer ongoing training and development opportunities to ATSEP, enabling them to enhance their skills and stay up-to-date with industry advancements. Provide access to relevant courses, workshops, conferences, and certifications to support their professional growth.

b. *Status Recognition*: Advocate for the recognition of ATSEP inclusion in ICAO Annex I as a job accreditation scheme and status recognition of safety importance element for ATSEP. Work collectively to establish industry-wide ATSEP licensing framework that not only ensure competence but also professional status to ATSEP

c. *Career Progression, job security and Advancement*: Create clear career progression paths for ATSEP, allowing them to see opportunities for growth within the organization. Offer mentorship programs, job rotations where possible and leadership development initiatives to nurture their career advancement. Emphasize the importance of continuous professional development for ATSEP. Encourage participation in training programs, conferences, workshops, and industry events to keep professionals up to date with the latest technological advancements and best practices.

d. *Recognition and Rewards*: Implement recognition programs to acknowledge the contributions and achievements of ATSEP. Provide competitive rewards, bonuses, and incentives based on performance and significant contributions to motivate and retain talented personnel.

e. *Work-Life Balance*: Promote a healthy work-life balance by offering flexible work/ rostering arrangements, such as flexible schedules or remote work options when feasible. Encourage a supportive and inclusive work culture that values the well-being of employees.

f. *Technology and Innovation*: Invest in state-of-the-art technologies and tools that enhance the capabilities of ATSEP. Provide them with access to cutting-edge equipment and systems, enabling them to work efficiently and stay engaged in their roles.

g. Collaboration and Teamwork: Foster a collaborative work environment that encourages teamwork and knowledge-sharing among ATSEP. Promote interdisciplinary collaboration, where they can learn from each other's experiences and collectively contribute to solving complex challenges. The same with other professions e.g ATCO, AIS or AFISO in teamwork towards common goals, exchange of ideas, promoting interdisciplinary cooperation and mutual understanding.

h. *Feedback and Communication*: Establish open lines of communication with ATSEP to understand their needs, concerns, and suggestions. Conduct regular performance reviews and provide constructive feedback to help them improve and align their skills with ANSP requirements and management to understand ATSEP requirements.

i. *Competitive Compensation and Benefits*: Ensure that ATSEP are well compensated in line with similar industry professions. Regularly assess salary structures and benefits packages to remain competitive and demonstrate that their contributions are valued.

j. *Safety and Cybersecurity Culture*: Foster a strong safety and cybersecurity culture within the organization, emphasizing the importance of safety and security in air navigation services. Provide ATSEP with the necessary resources, training, tools and support to prioritize safety in their work.

k. *Employee Engagement*: Create opportunities for ATSEP to provide input and contribute to decision-making processes. Involve them in projects and initiatives that align with their interests and strengths, making them feel valued and engaged in their roles.

An involved and appreciated employee is far more involved than one that is not or partially appreciated. This is not an easy task as it necessitates that the management side understands (which is demanding) and appreciates the ATSEP contribution to the ANSP final product. If ATSEP feel that they are not part of it, they will not be as involved and motivated. ANSPs need to inform and involve ATSEP in their business plans.

l. *Psychological support*: As in any other safety critical job with extended working hours (24/7) the effects of fatigue and stress should be handle professionally. Also in cases of incident or accidents implementing CISM principles will certainly improve the job perception.

By implementing these strategies, ANSPs and organizations can enhance the retention of current ATSEP and ensure they have the necessary skills to advance the aviation industry in the 21st century. Providing continuous professional development, career progression opportunities, work- life balance, recognition, and a supportive work environment will contribute to the satisfaction and engagement of ATSEP, fostering their commitment to the organization and the industry

Professional associations such as and IFATSEA (International Federation of Air Traffic Safety Electronics Associations) and industry CANSO (Civil Air Navigation Services Organization) can collaborate with aviation firms and other stakeholders to ensure that the industry attracts and retains talent from a diverse employment pool through the following approaches:

x) *Collaboration and Networking*: Associations can facilitate collaboration and networking opportunities among ANSPs (Air Navigation Service Providers), aviation firms, and other stakeholders. This can include organizing conferences, workshops, and forums where industry professionals can share experiences, exchange ideas, and collaborate on initiatives aimed at attracting and retaining diverse talent. Combine efforts through mutual understanding and appreciation of the ATSEP job.

y) *Skills Recognition and Transferability*: Establish frameworks for assessing and accrediting relevant skills and competencies, ensuring a smooth transition and facilitating career progression. The best approach to this is the inclusion of the ATSEP Profession in ICAO Annex 1 and subsequent licensing like the Pilots, aircraft avionic engineers and ATCO.

z) *Promote Diversity and Inclusion*: Industry associations can actively advocate for diversity and inclusion within the aviation industry. They can develop policies, guidelines, and best practices that encourage organizations to foster inclusive work environments and address barriers to diversity. This can includepromoting equal opportunities, combating bias, and supporting initiatives that encourage diversity in recruitment, retention, and career progression.

w) *Scholarship and Financial Support*: Collaborate on initiatives to provide scholarships and financial support for individuals interested in pursuing a career as ATSEP. Establish funding programs, sponsorships, or partnerships with educational institutions to attract and support talented individuals.

Ø) *Internship and Apprenticeship Programs*: Create internship and apprenticeship programs in collaboration with ANSPs and industry stakeholders. These programs provide hands-on training and real-world experience to individuals interested in entering the ATSEP profession, allowing them to acquire the necessary skills and knowledge.

&) *Collaboration with Educational Institutions*: Associations can collaborate with educational institutions like technical colleges or universities to promote careers in the aviation industry, particularly among underrepresented groups. This can involve participating in career fairs, providing guest speakers, offering internships, and establishing scholarship programs to attract diverse talent and expose students to the opportunities within the industry.

$) *Policy Advocacy*: Industry associations can advocate for policies and regulations relating to the Human factor within the aviation industry. They can collaborate with regulatory bodies, governments, and other relevant organizations to influence and cross fertilizepolicies that promote hiring of the necessary qualified individuals by equal opportunities, diversity, and non-discrimination.

By working together, industry associations, ANSPs, aviation firms, and other stakeholders can leverage their collective resources, knowledge, and influence to create a more diverse and inclusive aviation industry. Through collaboration, education, awareness, and the sharing of best practices, they can attract and retain talent from diverse backgrounds, fostering innovation, creativity, and a stronger workforce for the future.

IFATSEA remains available to provide our professional expertise to all collaborating organizations and institutions on the question of human resources in aviation especially ATSEP. We also expect and invite international organizations like ICAO, and HERMES to embark on activities that will secure the best Professionals for the Total Aviation System.

Ref.1: SJU Air Space Architecture study (https://www.sesarju.eu/sites/default/files/2019-05/AAS_FINAL_0.pdf)

Ref.2: Legal, economic, and regulatory aspects of ATM data services provision and capacity on demand as part of the future European air space architecture (https://op.europa.eu/en/publication-detail/-/publication/fd53d20f-3b60-11eb-b27b-01aa75ed71a1)

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Aeronautical HF Spectrum: The Old but Gold

The use of aeronautical High Frequency (HF) bands continues to play a vital role in aviation communication. The frequency range between 2850 kHz and 22000 kHz, allocated to the aeronautical mobile (R) service, provides essential long-distance communication for aircraft operating in oceanic or remote regions, forming a crucial part of aviation safety.

Abdul Aziz,
ANS Inspector, DGCA Indonesia

From a technical perspective, HF bands possess unique propagation characteristics compared to other aeronautical frequency bands like VHF and UHF. HF signals can travel long distances by bouncing off the ionosphere, a phenomenon known as skywave propagation. However, HF signals are also influenced by atmospheric conditions, solar activity, and the time of day, adding a layer of complexity to their use.

To manage these complexities and prevent harmful radio interference from non-aeronautical sources, the utilization of HF bands involves coordination between two key international organizations: the International Civil Aviation Organization (ICAO) and the International Telecommunication Union (ITU). These organizations collaborate to implement measures that minimize interference, ensuring the harmonized and efficient use of the spectrum.

Beyond supporting Air Navigation Services operations, HF bands are also used by aircraft operating agencies for Aeronautical Operational Control (AOC), particularly in flight-following activities. While well known for air-ground voice communication, HF also includes HF data link (HFDL) that has evolved to support various operational control (AOC) and Air Traffic Services (ATS) applications, such as Controller-Pilot Data Link Communication (CPDLC) and ADS-C reporting. Notably, the use of HF bands for such services is becoming increasingly common worldwide.

Going into more detail about the technical and operational use for establishing the HF band allotment plan, Appendix 27 of the ITU Radio Regulations outlines a comprehensive framework. This plan identifies the frequencies that are to be used in specific geographic areas without assigning them to particular stations.

The carrier frequencies designated for use within the HF bands can be found in provision 27/19 of Appendix 27. These frequencies are grouped into specific allotment areas, ensuring that they are allocated in a manner that avoids interference and maintains communication efficiency across different regions. Further details regarding the assignment of frequencies to these areas are elaborated in the same document, providing a structured approach to spectrum management in the aeronautical mobile (R) service.

Additionally, to meet the operational requirements in the Asia Pacific Region, the ICAO Regional Office, in accordance with provision 27/21 of the ITU Radio Regulations Appendix 27, agreed to establish further sectorized sub-networks. This policy was initially developed during the ASIA/PAC/3 RAN Meeting in 1993 to address the region's growing demand for HF communication and ensure efficient frequency use.

Further discussions regarding HF frequency allocations occurred during the deliberation of Frequency List No. 4 in 1999, with a subsequent review in 2007, though no further policies have been adopted since.

Looking ahead to future challenges, it is essential to consider the ongoing agenda of the World Radiocommunication Conference (WRC), organized by the ITU every four years. For the aviation community, decisions made at the WRC are crucial as they directly affect the allocation of frequencies used by aviation systems. These decisions can impact a wide range of communication and navigation services, potentially introducing new frequency allocations, updating existing regulations, or reallocating spectrum to accommodate advancements in aviation technology, the possibility of reallocating HF bands may emerge in future WRC discussions. As aviation heavily relies on secure and reliable radio frequencies for safety and operational efficiency, any changes decided at the WRC must be carefully evaluated and aligned with the needs of the aviation sector.

To address the aforementioned issues, ICAO, in collaboration with its member States and the relevant Working Group, is actively encouraging all States and administrations to maintain accurate and up-to-date information in the ITU Master International Frequency Register (MIFR). This is a critical first step in ensuring that accurate data is available for decision-making on future issues related to frequency use.

In parallel, ICAO also emphasizes the need for the promulgation of the ICAO HF frequency list No. 4, which is essential for ensuring compliance with regulatory requirements. This list will serve as a key resource for harmonizing frequency usage and maintaining the safety and efficiency of global aeronautical communications. The combination of maintaining up-to-date information in the MIFR and having a comprehensive ICAO HF frequency list will facilitate smoother regulatory processes and ensure that aviation systems continue to operate without interference or spectrum shortages.

In conclusion, I would like to reiterate the key point highlighted by IATA during the ICAO APAC Frequency Use Seminar in Bangkok in September 2024, “continued use of legacy C, N, and S technologies will protect our spectrum.” Indeed, despite being an older technology, HF bands remain indispensable to global aviation operations, earning them the title of "old but gold."

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Do you know?

Sunspots are the region of intense magnetic activity, responsible for several harmful eruptions from sun surface and capable of causing disruption to satellite operations.

The Emerging Concept of UTM System for Seamless Drone Flights

The Indian Prime Minister, in his Independence Day speech in 2022, has called for making India a developed nation by 2047. Government of India have also planned to make India a Drone Hub in the world by 2030. India's UAS market is expected to grow at a compound annual growth rate (CAGR) of 15–20% over the next decade.The Indian drone industry is growing rapidly and is expected to reach a value of $1,437 million by 2029.

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Drones are used for a variety of commercial and military purposes, including surveillance, inspection, precision farming, search & rescue, and last-mile logistics. The growth of the drone industry is driven by several factors such as favorable government regulations, an increasing number of startups, and technological developments. The Airspace Management Directorate is playing a key role in the development of UAS sector by investing in research and development, planning and creation of Very Low-Level Airspace for drones, development of Unmanned Traffic Management (UTM) system. Indian government have planned to become a drone hub in the world by 2030. As of today 20,000, drones have been registered in India which is 36 times the number of drones registered in 2021. It is expected that there will be 2 lakhs of drone flying in the airspace in the coming 1-2 years.

Advanced Air Mobility is an emerging concept for passenger transportation. The market size was valued at USD 9.76 billion globally in 2023 and is expected to grow at a CAGR of over 20% between 2024 and 2032. The Indian government has encouraged advancements in electric and hybrid-electric propulsion systems, as well as the development of autonomous flight technologies. Infrastructure development such as vertiports will be essential in the coming decade for Passenger and Cargo transportation with eVTOL.

Current Air Traffic Management (ATM) systems have not been designed to handle the traffic from unmanned aircraft. Integration of unmanned aircraft in the Indian airspace using conventional means may require unmanned aircraft to be equipped with bulky and expensive hardware, which is neither feasible nor advisable. This requires the creation of a separate, modern, primarily software-based, automated UAS Traffic Management (UTM) system. Such systems may subsequently be integrated into traditional ATM systems.

The Unmanned Aircraft Traffic Management (UTM) system is a solution designed to ensure the safe and efficient coexistence of unmanned aircraft systems (UAS) with other airborne and ground-based traffic. UTM systems are essential for integrating drones, or Unmanned Aerial Vehicles (UAVs), into controlled airspace safely. It facilitates real-time coordination, tracking, and communication between drones, manned aircraft, and ground operators. Both India and several other countries are working on UTM development to enable drone operations for commercial, emergency, and public safety purposes.

UTM system will be useful in performing following functionality:

- Drone identification and registration – to allow airspace managers to identify and communicate with each drone flying in the airspace, and to identify a rogue drone.

In 2021, MoCA has published National UTM policy framework which envisages the establishment of an Unmanned Aircraft Traffic Management (UTM) System and sets the stage for Beyond Visual Line of Sight (BVLOS) operations in India.

- Pre-flight management, airspace management, flight management tool – to give an accurate and up to date picture of the airspace, including data on obstacles, other drones, weather etc. This includes geo-fencing and automatic/instantaneous flight approvals.
- Collision avoidance (for obstacles and other drones) – in the form of a detect-and-avoid system
- Communication – to ensure real time communication between the drone and its operator and the airspace manager to enable the flight manager to dynamically alter the drone trajectory in case of unforeseen emergencies.
- Navigation – to allow drones to navigate themselves with precision in all conditions, and to comply with airworthiness standards.

- Airspace management: The platform manages the airspace map for drone operations, which is divided into red, yellow, and green zones. Airspace Management Agencies can add, change, or remove these zones.

- Unique Identification Number (UIN): Users can apply for a UIN on the platform by filling out Form D-2, paying a fee, and submitting the form.

- Certificate of Compliance: Manufacturers can apply for a Certificate of Compliance on the platform.

- RPAS approval: Pilots can register and verify approval of their RPAS on the platform.

Digital Sky implements a no permission, no takeoff (NPNT) policy, ensuring that drones cannot take off unless they have been pre-cleared by the UTM system. Also, it supports real-time drone tracking, dynamic airspace management, and operator identification, playing a central role in safe drone operations.

Airspace Management

The Indian airspace for drones is divided into three zone such as Green, Yellow and Red.

Green zone is the airspace up to a vertical distance of 400 feet that is not designated as red or yellow zone. No permission is needed for flying in this zone.

Yellow Zone is the airspace which is above 400 feet in green zone, and airspace above 200 ft within 8 to 12km from an airport. It is a restricted zone where drone operations need permit.

Red Zones fall under Airport Premises and Restricted Areas where Drone Operation is prohibited.

Drone Corridor Development

Airspace Management Directorate is planning to develop drone corridors to facilitate operations such as drone deliveries and inspections in designated airspaces. UTM systems will be essential for managing traffic in these corridors.

Future Development

As drones play an increasingly important role in logistics, surveillance,

, agriculture, and urban air mobility, UTM systems will become crucial for managing the complexity of airspace traffic. The focus will be on:

- Scalability: Handling increasing numbers of drones.
- Automation: Introducing AI and machine learning for predictive air traffic management.
- Safety and Security: Ensuring data privacy, secure communications, and conflict avoidance systems.

- Geofencing: Creation of the RED, Yellow and Green zones for the drones will not be sufficient to contain the drone in the designated area of the operation. Concept of geofencing need to be implemented to contain the unmanned aircraft system in the designated area of the operation. Geofencing will be beneficial in ensuring the airspace safety and privacy. Also, it will be useful in mid-air collision avoidance.

- Detect and Avoid: Detect and Avoid technology is essential for the collision avoidance and to facilitate Beyond Visual Line of Site (BVLOS) operation. The system is capable of detecting, tracking and reporting in real time the presence of intruders in the surrounding airspace and providing the guidance necessary to perform avoidance manoeuvres either manually or fully automatically. The system will be useful in operating the drones in controlled airspace.

- RIT (Remote Identification Technology): Unlike manned aircrafts drones will be required to transmit the data such as position, altitude, direction.

Remote ID technology will provide identification and location information of drones that can be received by other parties through a broadcast signal. Remote ID also helps the law enforcement, and other agencies locate the control station when a drone appears to be flying in an unsafe manner or where it is not allowed to fly.

- Noise Management: current literature states that the drone noise is more substantial than the noise created by the road traffic or airplane. Drone corridor over populated and sparsely populated areas will be useful to reduce the impact of the noise on the ground.

- Emergency Response, Search and Rescue (SAR): Drones will play vital role in providing emergency response services. Guidelines will be developed for the facilitation of the emergency services by the drones such as giving priority over other drones. Creation of the temporary reserved airspace for drones by implementing dynamic airspace allocation.

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Experiencing Space Weather

Dr Surendra Sunda
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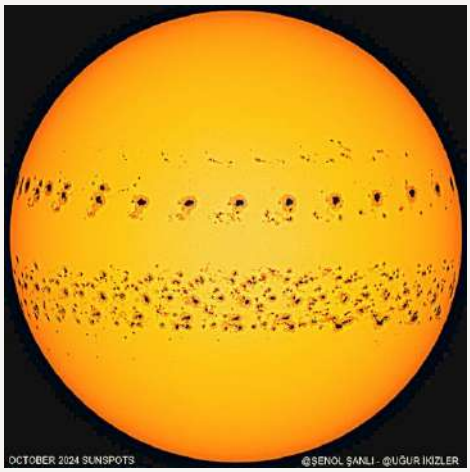
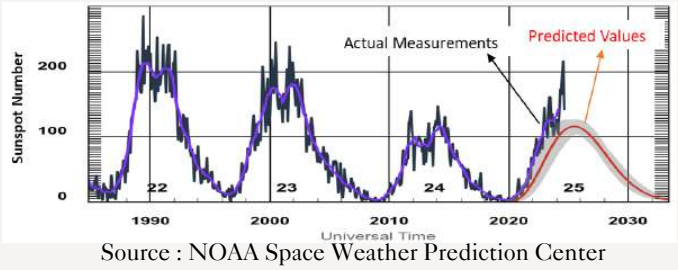


Fig 2: Sunspots during October 2024.

Sun is the primary source of energy needed to ionize the Earth's atmosphere, known as ionosphere, which is situated from 90 km upwards. The Sun has 11-year solar cycles where solar activity varies from low, medium to high. During high solar activity, the sun's magnetic poles flip. It is generally measured using the sunspot number as shown in Figure 1. Sunspots are cooler regions on the sun caused by a concentration of magnetic field lines. They are the visible component of active regions. These are areas of intense and complex magnetic fields on the sun that are the source of solar eruptions. As the Sun rotates on its axis once in about 27 days, the sunspot will be visible for several days. The composite image of sunspot during October 2024 is shown in Fig 2.



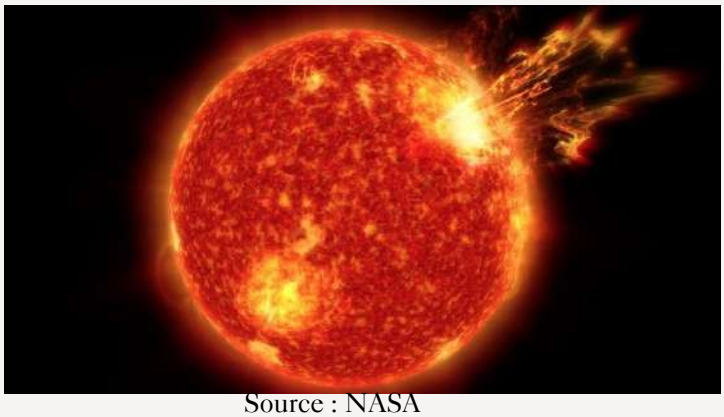
Source : NOAA Space Weather Prediction Center

Figure 1: 11-year Solar cycle exhibiting solar minima and Maxima.

The current solar cycle is defying the estimates as it progresses suggesting that sun is unpredictable. The solar cycle 25 was estimated to be weaker and similar to previous cycle. However, it continued to be stronger from the beginning of solar cycle in year 2020. During June 2024, the sunspot number were measured to be highest since last 20 years. Recently, the NASA, the National Oceanic and Atmospheric Administration (NOAA) and the international Solar Cycle Prediction Panel announced that the sun has reached its solar maximum period in 2024. It has reached maxima one year earlier than previous estimates and expected to remain high for 1-2 years.

During high solar activity, the Sun produces more Coronal Mass Ejections (CMEs) and solar flares causing geomagnetic storms over Earth. These storms caused disruptions in high-frequency radio communications, electric power grids, satellite navigation systems and pose risks to spacecraft and astronauts.

So far, more than 35 solar storms were reported in current solar cycle starting from 2020. The powerful solar explosions during May 2024 produced the most severe geomagnetic storm to affect Earth since March 1989. It even triggered a rare aurora display on 10 May 2024 in Leh, India, which was recorded by India's highest observatory at Hanle.



Source : NASA

Fig 3 : Solar explosion producing Coronal Mass Ejection (CME)

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Do you know?

Real name of GPS is NAVSTAR-GPS (NAVigation System using Timing and Ranging), a baseline constellation of 24 MEO satellites, primarily used for PNT.

Overview on handling unauthorized remotely piloted Aircraft System (RPAS) from civil aviation point of view

Sekhar Acharjee
AGM (CNS), AAI
NSCBI Airport, Kolkata

Introduction

Remotely piloted aircraft systems (RPAS), commonly referred to as "drones" ,represent tremendous economic and innovation opportunities. With an ever-growing number of drones taking to the skies, their safe and secure integration into the airspace poses the main challenge to enabling the market. With this challenge in mind, it is noted that the number of incidents involving drones has steadily increased in Europe and around the globe over recent years. In most cases, unauthorized drones are being reported near or inside the perimeter of airports (or in its immediate proximity) or in the arrival and departure paths of runways, which aircraft use at landing or take-off. Given the potential for disastrous effects following a collision between a manned aircraft and a RPAS, aerodrome operators and Air Navigation Service Providers (ANPSs) may, in managing such an incident, often have no option but to stop or restrict runway operations, leading to a severe disruption to air traffic.

Taking note of severity of situation, ICAO specialized groups initiated developing Standards and Recommended Practices (SARPs),Procedures and Guidance material for remotely piloted aircraft systems (RPAS), to facilitate safe, secure, and efficient integration of remotely piloted aircraft (RPA) into non-segregated airspace and aerodromes while maintaining the existing level of safety for manned aviation.

Background

Since advent , Unauthorized drones in the surroundings of aerodromes represented a latent/ potential threat, but it took the events at London Gatwick airport in December 2018 to bring it to attention of the public and the authorities.

Between 2019 and 2021 December a total of 115 drone sightings over airport of London-Gatwick were reported lead to the closure of its single runway. During the disruption, which lasted 33 hours, over 1,000 flights had to be cancelled, thereby affecting some 140,000 passengers. Since then, several other drone incidents took place across world, with a varying degree of disruptions on aerodrome operations.

Challenges

While each incident is specific and dynamic, certain common factors are often at play. Firstly, incidents tend to appear – and sometimes can escalate - very quickly. Readily available "race" drones can reach speeds of 80 kilometers per hour. At such a speed, it would, for example, take less than 4 minutes for a drone to move from being outside a 5-kilometre protection zone to the runway itself. Secondly, incidents are dynamic as drones continue to fly and move around with flight patterns much more agile than manned aviation. Thirdly, it is often difficult to confirm reliably a sighting, as the drones generally being tiny are hard to be individually identified, leading to uncertainty in determining if one or more drones caused the disruption, Fourthly, complexity in developing technical & procedural solution(needs development as well as promulgation of new rules & regulations) for each diverse airspace structure ,Lastly, it is often difficult to locate the remote pilot & the drone, very few airport boasts of tools to detect and suppress drone movement, the problem amplifies at aerodromes that rely on the human based detection of drones.

Over time, commercial drone operations surely will be integrated in the air transport system.

However, the unauthorized operation of a drone in the surroundings of aerodromes is not an integration problem. It is in fact similar to an unauthorized manned aircraft in the surroundings of an aerodrome, and in neither case has the aircraft been approved for the operation in that air space. Unfortunately, the identification of a small RPAS in this situation is demonstrably far more difficult. Equally, the pilots/ operators of unauthorized UAS cannot be easily identified, nor tracked, and excluded from the airspace where they pose the greatest safety risk and even a potential security threat to civil aviation.

Probable Solutions

First step shall be framing of suitable rules & regulations followed by sustained awareness campaign among different stakeholders. Airport operators and ANSP shall equip themselves with tools to detect intrusion of RPAS in their intended coverage volume of responsibility. Similarly appropriate drone suppression tools also shall be deployed in airport based upon threat perception / safety assessment. Procedures need to be designed so that key stakeholder(ANSP/Airlines/Law enforcing agencies/local authorities, etc) know action to be performed when rogue RPAS are detected . Lastly, integration of RPAS management system along with CNS-ATM Automation systems shall pave the way of early identification , classification of threat and decision making.

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DFMC GNSS: A Game Changer

Anurag Gupta
DGM (CNS), AAI, Bengaluru

Introduction

As they say, change is only constant which is mostly true for aviation related technologies, one of them is ever evolving GNSS based navigation technology in the field of Civil aviation i.e. DFMC (Dual Frequency Multi Constellation) GNSS which employs Dual Frequency and multiple core constellation satellites for solutions.

Current civil aviation use of GNSS is predominantly based on a single frequency of a single GNSS satellite constellation, namely the L1 frequency of the US Global Positioning System (GPS) constellation, which provides the foundation for the global implementation of PBN and automatic dependent surveillance (ADS). Similarly, Indian L1 SBAS i.e. GAGAN (GPS Aided GEO Augmented Navigation) is also augmenting the single frequency GPS satellite constellation.

Within the Russian Federation, similar applications based on a single frequency of the GLONASS constellation are in operation. In addition to PBN and ADS, GNSS is also used in many other aircraft applications that require position or time information.

They include aircraft systems (such as the ground proximity warning system) that have led to significant improvements in safety. Since the introduction of GNSS in aviation, there has been increased dependency on GNSS position and time, and it is expected that this trend will continue as new applications are introduced and the conventional navigation infrastructure is rationalized.

Evolution towards DFMC GNSS

The evolution of the various GNSS elements towards DFMC will take place gradually. GNSS constellations of minimum 24 satellites offering dual-frequency signals expected to be operational by 2030-time frame.

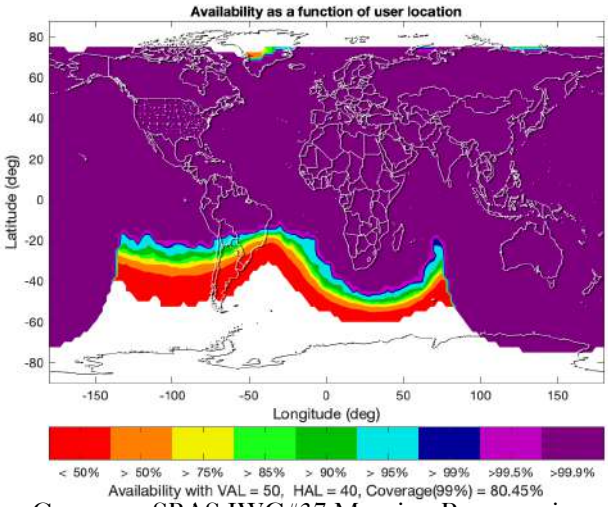
A number of States and regions also plan to deploy DFMC satellite-based augmentation systems (SBAS), India is one among them. Even after the introduction of DFMC, current GNSS services and equipment will remain a solution for many aircraft and will be supported by the DFMC infrastructure in a backwards compatible way.

Working Principle and Benefits

Ionospheric (Iono) errors is the dominant and unpredictable source of error in the GNSS based single frequency solutions especially over Iono active regions like India.

It becomes even worse during equinox and near solar max (peak of 11-year solar cycle). Current single frequency GNSS does not remove Ionospheric related errors completely. The use of dual frequencies will help mitigate vulnerabilities in respect of ionospheric disturbance and of radio frequency interference affecting a single frequency. For example, when using the DFMC SBAS service, the user computes an ionosphere-free dual-frequency pseudo-range measurement based on the differential ionospheric delay between the two frequencies, instead of using an SBAS ionospheric delay correction parameter. Therefore, an SBAS ionospheric delay correction parameter is not needed.

DFMC SBAS service provides improved availability, continuity, and tighter alert limits compared to L1 SBAS, by using ranging sources from two frequencies to provide direct ionospheric delay measurements. This results in two effects as follows: DFMC SBAS service will have more resilience to ionospheric activity, and the service area in which DFMC SBAS can support approach operations with vertical guidance will be much broader than the L1 SBAS service area since there is no dependency on the location of the ground reference receivers to estimate the ionospheric delay. Thus, DFMC SBAS enables the provisioning of SBAS service in regions of active ionosphere where availability and/or continuity of an L1 SBAS. Typical APV-1 99% coverage map world wide with DFMC SBAS would look like as given in below figure in future.



Courtesy: SBAS IWG#37 Meeting Presentation

Dual Frequency / Constellation With Future SBAS Systems

The availability of multiple constellations will also contribute to mitigate ionospheric scintillation and the risk of having insufficient satellites within a single constellation. These technical improvements will enable operational benefits in terms of safety and efficiency, such as improved operational reliability for CNS applications, increased deployment of 3D instrument approach operations worldwide in line with ICAO PBN Global goals, increased accessibility, fuel savings, cost reduction, introduction of innovative operational concepts and applications, and continued rationalization of conventional navigation aids. The value of these operational benefits will vary among different stakeholders. Due to sever Ionospheric disturbances, currently, 99% (of time) availability APV-1 coverage area is less over India using L1 SBAS but after introduction of DFMC SBAS, this coverage would improve and even it would enable SBAS Cat-1 services at all the Indian Airports through the year.

Hence, Indian civil aviation would be the biggest beneficiary of DFMC GNSS mainly DFMC SBAS by utilizing the existing GAGAN infrastructure.

DFMC Standards Status

1.Core Constellation

All the Annex 10 standards for Core Constellation has already been published in ICAO Annex 10 Vol I, July 2023 and became applicable from 2nd Nov 2023 onwards. How ever status of each Core Constellation follows.

The GPS modernization program will introduce GPS III satellites and a new ground control segment. The GPS modernization program will provide three new civil signals with three of the four civil signals (L1 C/A, L1C and L5) being located within bands appropriate for aviation use.

These signals were selected to be compatible and interoperable with other constellations' signals. L5 Full Operational Capability provided by 24 satellites is planned for 2029.

Russian Federation's GLObal NAvigation Satellite System (GLONASS) has 24 satellites and is fully operational for aviation use in the L1 frequency band using frequency division multiple access (FDMA).

GLONASS became operational with code division multiple access signals (CDMA) in the L3 band on all satellites in 2022 on 24 staellites. The further implementation of L1 CDMA signals is planned to be completed by 2028 and retain backward compatibility with the FDMA signals.

The Galileo constellation has currently a total of 22 FOC (Full Operational Capability) satellites.

Galileo will provide E1 and E5 signals for aviation use and these signals are compatible and interoperable with GPS L1 C/A, L1C and L5. The Full Operational Capability of Galileo with 24 satellites may be achieved by 2026.

China's BDS (BeiDou Navigation Satellite System) is currently deploying satellites to populate and validate the constellation. BDS provides B1I, B1C and B2a signals for aviation use and the B1C and B2a signals are compatible with L1C and L5. The nominal constellation consists of 30 satellites (24 MEO, 3 GEO, 3 IGSO).The constellation was declared "complete" on 23 June 2020.

2. Augmentation System

DFMC SBAS Standard has already been published in ICAO Annex 10 Vol I, July 2023 and became applicable from 2nd Nov 2023 onwards.

International development activities for DFMC GBAS are already in progress.

Advanced RAIM (ARAIM) techniques are being developed as an ABAS augmentation for use under multi-constellation operations for which SARPs are being developed.

3. .Aircraft Receiver

The Radio Technical Commission for Aeronautics (RTCA) has released a six-file document titled "DO-401 Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation Satellite-Based

Based Augmentation System Airborne Equipment."

This SBAS MOPs document does not provide specifications for a production approval. A future release of the document will provide requirements supporting production approval, typically through a new Technical Standard Order or European Technical Standard Order.

Summary

Ultimately, the uptake of GNSS future multi-constellation avionics will depend on the business case for an individual aircraft operator, as determined by the expected operational benefits and the associated costs and challenges to be met. Usage and equipage requirements for DFMC GNSS should be performance-based and driven by expected tangible operational improvements. Nonetheless, its technical and operational benefits are immense as described above.

It will not be an exaggeration to say that DFMC GNSS technologies would be a game changer for civil aviation in general and Indian civil aviation in particular in view of the prevailing challenging Ionospheric conditions in India.

It has the capability to change navigation landscape scenario worldwide forever.

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References

- *ICAO Concept of Operations (CONOPS) for Dual-Frequency Multi-Constellation (DFMC) Global Navigation Satellite System (GNSS) v6.4, 27 April 2018*
- *ICAO Global Navigation Satellite System (GNSS) Manual, Fourth Edition (advance unedited) — 2023*
- *Wikipedia pages of BDS, Galileo and GLONASS*

Do you know?

NIC (Navigation Integrity Category) value in ADS-B message can be used as indicator of possible interference on GNSS signals.

Mobile ATC Tower (MATC): "Helping Airport Operations in AAI"

Ajay Kumar
DGM (CNS), AAI, CHQ

In aviation, Airports are multifaceted centre where defined coordination and communication are critical to ensure the safety and efficiency of Aircraft Operations. One of the essential components of this coordination is the Air Traffic Control (ATC) Tower, which oversees the flight movements on the ground and in the surrounding airspace. However, traditional ATC towers are fixed, and building them is a costly and time-consuming process. This is where mobile ATC towers come into picture, offering flexibility, quick deployment, and efficiency in various scenarios.

Mobile ATC Tower (MATC) is a self-contained, transportable unit that functions like a traditional control tower but can be rapidly deployed and relocated. MATC are housed in trailers mounted units, designed to be set up in minimal time. These towers are equipped with all the necessary communication and control systems to manage air traffic at small Airports.

AAI installed "Mobile ATC Towers (MATC)" at small Airports identified under Regional Air Connectivity Scheme of Govt. of India (UDAN) to facilitate ATS (Air Traffic Services) operation where infrastructure for ATC Control Tower does not exist or to be constructed in future.
The operation of the Mobile ATC Tower in India shall be governed in compliance with the standard guidelines issued by ICAO (International Civil Aviation Organization) in ICAO Annex 3, ICAO Annex 5, ICAO Annex 10 & ICAO Annex 11 etc.

Objective of deployment of these Mobile ATC Tower is rapid and easy deployment, even under harsh environmental conditions, combined with its operability completely independent from any infrastructure.

AAI had purchased Qty-8 Mobile ATC TWR (MATC) in year 2017-18 and installed and commissioned at Jagdalpur, Bilaspur, Utkela, Jeypore, Bokaro, Vellore, Hollongi & Rewa Airport to facilitate ATS operation. Further as and when the permanent ATC Tower is constructed at these Airport, the Mobile ATC TWR (MATC) may be diverted and deployed at other small/RCS Airport for ATS operation as per requirement of AAI Management.

Features & Integrated facilities available in Mobile ATC Tower (MATC):
1.Hydraulic Mobile ATC Trailer & Tower Cabin
2.VHF TX/ RX, VHF Manpack, FM Base with Walkie Talkie Sets
3.VCCS with 2 CWPs Positions & DVR Set with 32 Channel Capacity,
4.UPS-10 KVA in dual redundant Configuration (10 HRS Backup)
5.DG Set-Qty-1 of 20 KVA, 3 Phase, 440 V, Fuel Capacity 9 HRS on full Load
6.Metrological Equipment's/AWOS-Wind Sensor/Wind Direction/Sensor-Temp/Humidity/Barometric Pressure/Sensor/Present Weather Sensor/MET Data Display
7.GPS with Antenna, Siren Bell and AC Rooftop etc.

- Mobile ATC Tower (MATC) is fitted with hydraulically operated lift enabling the tower cabin having minimum size of 150 Sq. feet to rise up to a Height of 08 (Eight) meters from ground level to rooftop of tower.

- Mobile ATC Tower is fitted with suitable stabilizers/outriggers (hydraulic/ mechanical operated); to give suitable stability at the operational height under specified weather conditions.

- Mobile ATC Tower is having two control panel for lifting/lowering of ATC tower, one in the ATC cabin and another near the bed of the trailer. Both the control panels have been provided with emergency stop switch.
- The AC supply wires from DG (Diesel Generator) set to ATC cabin is properly laid and concealed in a safe and secure manner, conforming to safety norms. The lifting mechanism of Mobile ATC Tower is automatically operated through switch operation. However, there shall be provision for manual operation in case of exigency conditions.
- During the operational state, the Mobile ATC tower ensures a 360-degree circular view for the controllers who can perform all visual air traffic service and control functions to handle safely takeoff and landing of Aircraft.

Inside View

Outside view

Advantages of Mobile ATC Towers:

1.Rapid Deployment: One of the most significant benefits of mobile ATC towers is their ability to be deployed quickly, offering a solution for short-term or urgent need basis for commencement of Airport operation.

2.Scalability and Flexibility: They can be easily moved and set up wherever needed, making them highly versatile.

3.Self-Sufficiency: Mobile ATC towers are designed to operate independently, with their own power supplies and communication infrastructure, making them suitable for remote, small or disaster-affected areas and helping Airport operation for the safety of flights.

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System Wide Information Management (SWIM)

Lalit Kumar Pawar
AGM (CNS), AAI, Shimla Airport
>

An Overview

In today's digital age, the efficient management of information across an organization is crucial for operational success and strategic decision-making. In simple words SWIM is Global Aviation Intranet. System Wide Information Management (SWIM) refers to the integrated approach of collecting, processing, and disseminating information across various systems within an organization. This holistic framework aims to enhance data visibility, accuracy, and accessibility, leading to improved collaboration and informed decision-making.

The SWIM Global Interoperability Framework-SWIM layers:

a) SWIM-enabled Applications of information providers and information consumers around the globe. Individuals and organizations, such as air traffic managers and airspace users, will interact using applications that interoperate through SWIM;

b) Information Exchange Services defined for each ATM information domain and for cross domain purposes, where opportune, following governance specifications and agreed upon by SWIM stakeholders. SWIM-enabled applications will use information exchange services for interaction;

c) Information Exchange Models using subject-specific standards for sharing information for the above Information Exchange Services. The information exchange models define the syntax and semantics of the data exchanged by applications;

4. *User-Centric Design*: For a SWIM system to be effective, it must be user-friendly. This involves designing intuitive interfaces and dashboards that allow users to easily access and interpret information. Training and support are also key to ensuring users can maximize the benefits of the system.

5. *Collaboration Tools*: SWIM promotes collaboration by integrating communication and project management tools within the information management system. This facilitates real-time sharing of information and enhances teamwork across departments.

Benefits of System Wide Information Management:

- *Improved Decision-Making*: With comprehensive and accurate information at their fingertips, decision-makers can make more informed choices, reducing risks and optimizing outcomes.
- *Increased Efficiency*: Streamlining information management processes minimizes redundancy and speeds up data retrieval, leading to operational efficiencies.
- *Enhanced Compliance and Security*: A robust SWIM framework helps organizations adhere to regulatory standards and protects sensitive information through effective data governance and security measures.
- *Greater Agility*: By fostering a culture of data-driven decision-making, organizations can respond more swiftly to market changes and emerging opportunities.

Challenges in Implementing SWIM:

While the benefits of System Wide Information Management are substantial, organizations may face several challenges during implementation:

- *Data Quality Issues*: Poor data quality can undermine the effectiveness of SWIM initiatives. Organizations must invest in data cleansing and validation processes.
- *Resistance to Change*: Employees may be hesitant to adopt new systems or processes. Effective change management strategies, including training and clear communication, are essential for successful implementation.
- *Integration Complexity*: Merging legacy systems with modern platforms can be technically challenging and may require significant resources and expertise.
- *Ongoing Maintenance*: SWIM systems require continuous monitoring and updates to ensure they remain relevant and effective in a rapidly changing technological landscape.

AAI Developed Proof of concept-based SWIM prototype system:

- Under AAI startup program M/s RTPL has developed indigenous SWIM prototype system that will help AAI to prepare a roadmap for the implementation of ground-to-ground SWIM infrastructure.
- This platform of System Wide Information Management (SWIM) aims to enable AAI (Airports Authority of India) to meet its next

d) SWIM Infrastructure for sharing information. It provides the core services such as interface management, request-reply and publish-subscribe messaging, service security, and enterprise service management; and

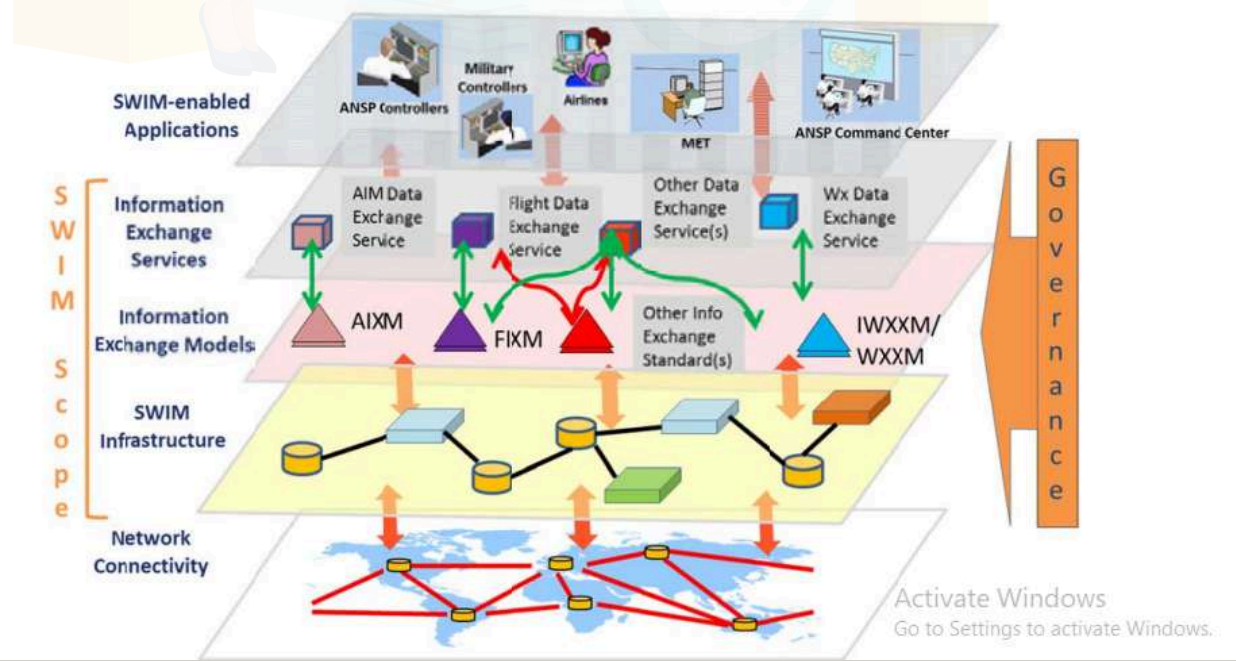
e) Network Connectivity provides consolidated telecommunications services, including hardware. This infrastructure is a collection of the interconnected network infrastructures of the different stakeholders. These will be private/public Internet Protocol (IP) networks.

Key Components of System Wide Information Management:

1. *Data Integration*: SWIM involves the integration of data from disparate sources, including databases, applications, and cloud services. By consolidating information, organizations can eliminate data silos and ensure that stakeholders have access to a unified view of relevant data.

2. *Information Governance*: Establishing clear policies and procedures for data management is essential. Information governance frameworks help organizations maintain data integrity, security, and compliance with regulatory requirements. This includes defining roles and responsibilities, data classification, and risk management strategies.

3. *Data Analytics*: Analyzing collected data is crucial for deriving insights that drive business strategies. SWIM incorporates advanced analytics tools and techniques, such as machine learning and predictive analytics, to identify trends, forecast outcomes, and support data-driven decision-making.



generation communication needs and facilitate the implementation of System Wide Information Management (SWIM) provisioned under Aviation System Block Upgrades (ASBU) B1-SWIM and B2-SWIM, and initiative under the umbrella of ICAO (International Civil Aviation Organization) and Euro-control.

- The project scope covered building SWIM Technical infrastructure, generating digital datasets for Digital NOTAM. OPMET & flight related ATS messages. At present SWIM Services, SWIM Digital Applications, and, most notably, SWIM Gateway services with AMHS and AFTN Switch have been developed and in- house testing had been carried out successfully.

- POC based SWIM project is aimed at operationally validating its deliverables developed in the spirit of SWIM core principles & capabilities and identifying the operational potential scenarios.

- Airports Authority of India (AAI) developed SWIM prototype system was interfaced with Aero Thai SWIM system for testing and validation of the project deliverables in order to confirm the bi-lateral flow of aeronautical, flight and weather data over the SWIM.

Discussion:

POC based SWIM project design supports Hybrid Operational Models and leverages the existing AMHS/AFTN networks to communicate with non-SWIM users.

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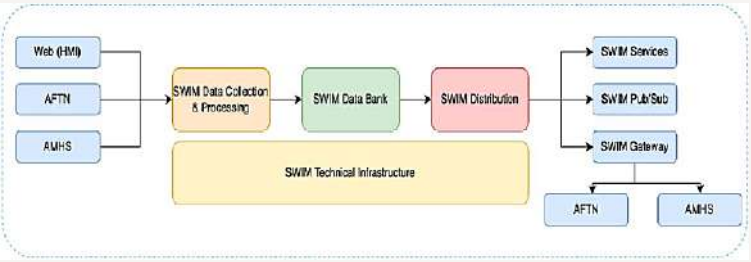
It is capable of distributing the aeronautical, flight and weather data through multiple channels subjected to operational rules and conditions.

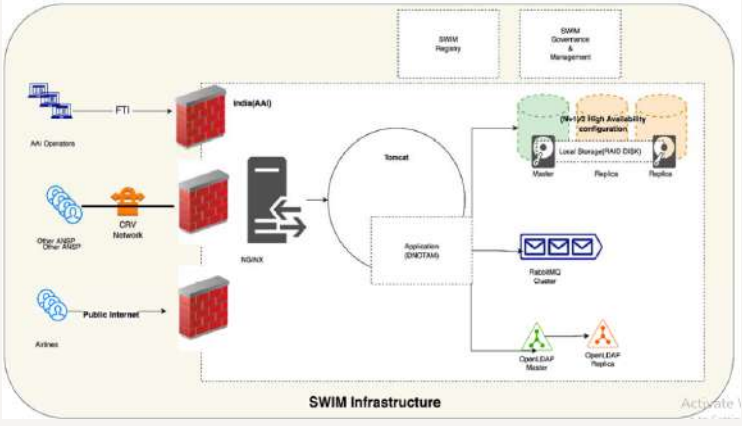
HMI Client applications are designed to support Hybrid capabilities. e.g., The Digital NOTAM application supports generating Digital NOTAMs as well as Traditional TEXT NOTAMs. The operator can toggle between the template options to issue and view both the NOTAM types. The same philosophy is extended to other digital applications as well.

Capabilities of the prototype SWIM System.

The below diagram summarizes the design philosophy of prototype SWIM system.



SWIM Infrastructure Developed for POC based SWM system is placed as below:



SWIM Technical Infrastructure:

(1) A clustered Messaging Service uses AMQP that offers QoS like High Availability and Message Delivery to exchange the SWIM data through a publish/subscribe model. It provides highly available and secure Database Engine to store and manage operational data.

(2) Web/REST Service hosting platform to host SWIM Services.

(3) A secure and reliable LDAP user registry to keep and manage SWIM system users.

(4) Message Security is achieved through Cryptography using PKI infrastructure and Digital Signatures.

(5) Information is encrypted using SSL protocol while it is being exchanged between systems.

(6) Trust framework is implemented using self-signed CA certificates to validate the client's identity and enforce trust between systems during systems integration.

Following SWIM services are part of the Architecture:

The following datasets were consumed during interfacing with Aerothai SWIM System:

- DNOTAM data in AIXM 5.1.1 format
- Flight Plan data in FIXM 4.2 format
- OPMET data in iWXXM 3.0 format

Implementation of SWIM in AAI:

The proof of Concept (POC) based SWAAIM/Wavex (System Wide Advanced Information Management) project under AAI startup policy was successfully completed in March, 2023. To harness the full potential, the SWIM Prototype System is handed over to CARO Hyderabad. The system is operational and its Trial operation was conducted at 20 AAI airports.

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Do you know?

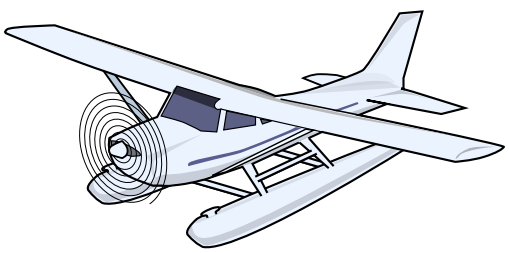
Our alma mater Civil aviation Training College was originally established as Civil Aviation Training Center (India) at Allahabad in 1948 for imparting training to Pilot instructors.

Kalaburagi Airport: A Practical Example

Understanding Aircraft Approach Systems: Precision and Non-Precision Approaches

Dr Chilaka Mahesh.,
Airport Director, AAI,
Kalaburagi Airport

Abstract— Aircraft approach systems are critical for ensuring safe landings, particularly under complex or adverse weather conditions. This paper explores the two primary methods of approach—visual and instrument approaches—emphasizing the importance of instrument approach procedures (IAP) in enhancing flight safety. Instrument approaches, divided into precision and non-precision categories, provide essential navigation aids when visual cues are limited, offering both lateral and vertical guidance in precision approaches like the Instrument Landing System (ILS) and lateral-only guidance in non-precision approaches such as DVOR/DME.



A case study of Kalaburagi Airport's ILS/LOC RWY 27 approach demonstrates how these systems work in practice, guiding aircraft to safe landings through structured procedures. From the perspective of airport operators, implementing robust instrument procedures significantly improves operational reliability, minimizes weather-related disruptions, and attracts airlines by providing consistent and dependable service. Additionally, airports that offer advanced instrument approaches are better positioned to meet international safety standards, which can enhance their competitive standing in the aviation market. The use of modern navigation systems like RNAV/GPS, which do not require extensive ground infrastructure, further increases the flexibility and attractiveness of airports to airlines, driving growth and revenue potential.

Keywords— Aircraft approach systems, Instrument approach procedures, DVOR/DME, RNAV/GPS

I. Introduction

When an aircraft takes off, it must eventually land safely at a destination airfield. The approach and landing phases of a flight are crucial, requiring systems that mitigate risks and manage the challenges involved. To ensure safety during these critical stages, approach systems have been developed, offering both visual and instrument-guided methods. These systems help pilots land safely, particularly in complex conditions where visibility is limited.

I. *Approach Procedures*

A. Types of Aircraft Approaches

There are two primary methods for an aircraft to approach and land at an airfield:

1. Visual Approach
2. Instrument Approach
   - Precision Approach (PA)
   - Non-Precision Approach (NPA)

In a visual approach, pilots rely on visual references and external landmarks to guide the aircraft toward the runway. This type of approach requires specific weather conditions, known as Visual Meteorological Conditions (VMC). When these conditions are not met, the flight operates under Instrument Meteorological Conditions (IMC). Under IMC, pilots follow Instrument Flight Rules (IFR), relying on navigation instruments instead of visual cues.

Both visual and instrument approaches aim to establish a stabilized descent toward the runway, allowing the pilot to make visual contact with the runway or other essential references in time for any necessary adjustments to land safely

B. *Instrument Approach Procedures (IAP)*

When visibility is reduced by factors such as fog, rain, or dust, a visual approach may not be feasible. In these cases, Instrument Approach Procedures (IAP) guide the aircraft using onboard navigation systems and ground-based aids, even when the pilot cannot see the runway until close to landing.

Instrument approaches are divided into two main types:

1. Precision Approach (PA): Provides both lateral (horizontal) and vertical guidance.
2. Non-Precision Approach (NPA): Offers only lateral guidance, requiring the pilot to manually manage the descent.

For instance, a DVOR/DME approach is a non-precision approach where pilots use a VOR station and a DME arc to navigate toward the runway. On the other hand, a Precision Approach like the Instrument Landing System (ILS) provides both lateral and vertical guidance, ensuring a more precise descent path.

III. Instrument Approach at Kalaburagi Airport: A Practical Example

At Kalaburagi Airport, one of the standard instrument procedures used is the ILS or LOC RWY 27 approach. This procedure helps aircraft approach and land safely, especially when visibility is low. The approach procedure involves the following key stages:

1. Initial Approach Fix (IAF): The aircraft begins its descent at points such as 13D or 18D from the VOR station, aligning with the runway using an 11DME arc while descending to 4000 feet.
2. Intermediate and Final Approach: At the Final Approach Fix (FAF) (4.7 DME), the aircraft aligns with the localizer course (268°) and descends to 3000 feet. It follows the ILS glide path or a manual descent gradient of 5.24% for the LOC-only approach.
3. Missed Approach Procedure: If the aircraft cannot land, the pilot climbs to 3000 feet and turns left to join the VOR holding pattern at 4000 feet or as directed by Air Traffic Control (ATC).

IV. Importance of Instrument Approach Procedures

Instrument approaches play a vital role in modern aviation, particularly under adverse weather conditions. By providing reliable navigation aids, they ensure that aircraft can land safely even when pilots cannot rely on visual references. This ability is crucial for maintaining flight schedules and avoiding disruptions due to poor visibility.

For an airport to support instrument approaches, it must meet specific infrastructure requirements, such as proper runway lighting, markings, and obstacle clearance zones. These features provide visual aids that enhance safety during the final approach and landing stages, helping to prevent runway overruns or Controlled Flight into Terrain (CFIT) incidents.

A. Airport Operator's Perspective: Benefits of Instrument Procedures

From an airport operator's perspective, having robust instrument procedures in place significantly boosts the operational reliability and attractiveness of the airport. By facilitating safe landings in diverse weather conditions, instrument approaches minimize flight cancellations or diversions, leading to a more consistent and dependable operation. This not only enhances the airport's reputation for reliability

but also reduces operational disruptions, allowing for smoother scheduling.

Additionally, airlines are more likely to choose airports equipped with advanced instrument procedures, as these systems enable higher flight frequencies and fewer weather-related delays. Reliable instrument procedures allow airlines to operate with confidence, improving passenger satisfaction and encouraging the development of new routes. This ultimately leads to increased air traffic, benefiting the airport by boosting revenue and creating more opportunities for expansion.

The availability of advanced instrument procedures also positions the airport as a competitive choice on a global level. Meeting international safety and operational standards enhances the airport's reputation among both domestic and international carriers, making it an attractive hub for air traffic.

V. *Navigation, Guidance, and Display in Approaches*

The success of instrument approaches relies on three core functionalities:

1. Navigation: Accurately estimating the aircraft's position relative to the intended flight path.
2. Guidance: Providing directional information to help pilots adjust their course.
3. Display: Presenting critical data to the pilot for effective decision-making.

Historically, navigation systems depended on ground-based aids like VORs and NDBs. Today, however, RNAV/GPS approaches are increasingly common. These approaches are more flexible and cost-effective because they rely on GPS coordinates rather than requiring extensive ground infrastructure. This makes RNAV approaches accessible to regional and smaller airports, further enhancing their appeal to airlines.

VI. *Conclusion*

Instrument approaches are essential for ensuring the safe landing of aircraft in all weather conditions. They provide precise guidance, allowing pilots to land safely even when visibility is limited. Airports like Kalaburagi, with their ILS/LOC RWY 27 approach, demonstrate the importance of these systems in improving reliability and safety. For airport operators, investing in robust instrument procedures not only enhances operational efficiency but also attracts more airlines, ultimately driving traffic growth and ensuring the long-term success of the airport.

Acknowledgment

The author expresses sincere thanks to Captain Ravi of Star Airlines for providing valuable insights and inputs that significantly enriched this article. His expertise and guidance have been instrumental in enhancing the understanding of aircraft approach systems.

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Do you know?

Way back in 1975, Civil Aviation Training Center used to provide training on RADAR Simulator

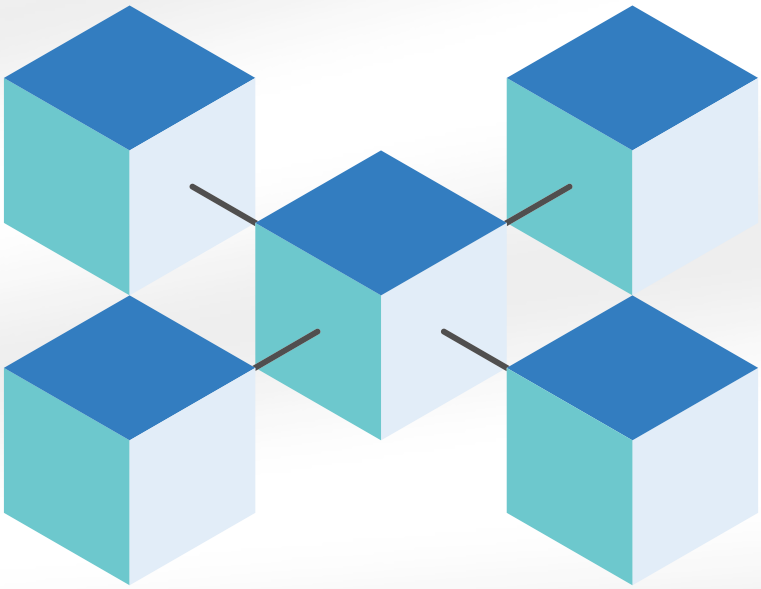
Block-chain for Cybersecurity in Air Traffic: Enhancing ATSEP Operations and Air Navigation Services

Puneet Kumar Mishra
AM (CNS), AAI, MUMBAI

Block-chain technology is rapidly gaining attention in cybersecurity, particularly for its potential to enhance secure data handling and system integrity across industries. In aviation, its application can significantly transform the work of Air Traffic Safety Electronics Personnel (ATSEP) and the broader Air Navigation Services (ANS) infrastructure. By leveraging block-chain's decentralized, cryptographically secure, and tamper-proof properties, aviation systems can improve operational efficiency, reduce security risks, and enhance the reliability of air traffic management (ATM) systems.

Block-chain in Cybersecurity: A Technical Perspective

Block-chain is fundamentally a distributed ledger technology where data is stored across a network of nodes rather than a centralized server. Each node holds a complete copy of the ledger, and updates are made through consensus algorithms like Proof of Work (PoW) or Proof of Stake (PoS). Block-chain's key features—decentralization, immutability, and cryptographic security—make it well-suited for enhancing cybersecurity by ensuring that data, once written to the chain, cannot be altered or tampered with without network-wide approval.



In cybersecurity, block-chain provides robust solutions for secure communications, integrity verification, and identity management. These aspects are critical for sectors where the security of data exchanges and the resilience of control systems must be guaranteed, such as in aviation.

How Block-chain Enhances ATSEP Operations?

Air Traffic Safety Electronics Personnel (ATSEPs) are responsible for maintaining and ensuring the reliability of technical systems critical to air traffic control and air navigation services. These systems include radar, communication equipment, surveillance systems, and navigational aids, all of which must function flawlessly to maintain safe airspace operations. Block-chain can have several technical benefits for ATSEP tasks:

1. *Immutable Maintenance Logs*: One of the core advantages of block-chain is its ability to create unchangeable logs. Block-chain can be used to store maintenance records, ensuring that all activities —whether they involve system updates, repairs, or calibrations—are securely logged and protected against unauthorized modifications. This ensures ATSEPs have access to accurate, verifiable data, which is critical during troubleshooting or post-incident analysis

For example, any system calibration performed by an ATSEP would be securely recorded on the block-chain, preventing tampering with the log files.

2. *Distributed Data Integrity*: Block-chain's decentralized architecture allows ATSEP data, such as radar outputs, system configurations, and performance logs, to be securely shared across multiple nodes. This reduces the risk of data corruption or loss that can occur in centralized systems, especially in the event of cyberattacks targeting a single point of failure. Block-chain can act as a distributed ledger for various system statuses and configurations, ensuring that every change is traceable and verified by multiple nodes, thereby maintaining data integrity.

3. *Secure Communication Channels*: ATSEPs and air traffic controllers rely on secure and continuous communication channels, particularly when managing high-stakes operations like system maintenance during active flights. Block-chain can create secure, encrypted communication pathways between ATSEPs, controllers, and other aviation stakeholders. By securing these interactions with block-chain's cryptographic protocols, the risk of communication hijacking or unauthorized access is minimized.

4. *Supply Chain Security*: ATSEPs manage various hardware and software systems that often involve complex supply chains. Block-chain's capability for transparent and verifiable supply chain tracking ensures that each component—

—whether a physical part like a radar sensor or a software patch—can be authenticated from its origin to its installation. This prevents the introduction of counterfeit or compromised components into critical systems, thus safeguarding the integrity of the ANS infrastructure.

5. *Disaster Recovery with Data Redundancy*: In the case of a cyberattack or system failure, block-chain's decentralized storage model ensures that critical system data remains accessible. ATSEPs can recover from disruptions more efficiently because block-chain maintains synchronized, tamper-proof records across multiple nodes, reducing reliance on a single point of recovery.

Impact on Air Navigation Services (ANS)

Air Navigation Services (ANS) are the backbone of airspace management, encompassing air traffic control, flight data processing, and communication networks. Block-chain can bring several technical improvements to ANS operations, enhancing system reliability, security, and interoperability:

a) System Integrity and Data Provenance: Block-chain enables the verification of data inputs from various systems such as radar, Automatic Dependent Surveillance–Broadcast (ADS-B), and satellite-based navigation. Each transaction in a block-chain ledger can be traced back to its source, ensuring that critical system data, such as flight paths or aircraft positions, has not been tampered with. This verification process bolsters the integrity of air traffic data and enhances the safety of air navigation services.

b) Cyberattack Mitigation: ANS infrastructure is increasingly susceptible to cyberattacks due to its reliance on digital systems for managing real-time flight data. Block-chain's distributed and encrypted framework reduces the risk of system-wide failure caused by a single cyberattack. Unlike traditional centralized systems, a block-chain-based ANS can continue functioning, even if one or several nodes are compromised, as the rest of the network can reject any unauthorized changes.

c) Seamless Data Exchange Between ANS Providers: In international air traffic management, seamless coordination between different ANS providers is critical. Block-chain can facilitate secure and consistent data exchange between these stakeholders. For example, flight information shared between ANS providers across different regions can be securely logged and verified using block-chain, ensuring that every system has access to the same accurate and authenticated data without risking data breaches or inconsistencies.

d) Automation and Smart Contracts: Block-chain supports the use of smart contracts—self-executing contracts where the terms of

the agreement are written into code. For ANS, this could automate processes such as billing between ANS providers, coordination of airspace usage, or even automating routine maintenance checks. Smart contracts can trigger automated actions when predefined conditions are met, reducing manual intervention and operational delays.

e) Cost Efficiency through Automation: The automation of data verification and logging provided by block-chain reduces manual oversight and the possibility of human error in ANS operations. Block-chain-enabled systems can automatically verify system changes, track aircraft positions, or manage flight data, streamlining the processes that currently require human validation and cutting operational costs in the long term.

Challenges and Considerations for Implementation

While block-chain offers significant cybersecurity benefits, its implementation in ATSEP operations and ANS comes with several technical challenges:

- Scalability Concerns: One of the major technical challenges with block-chain is its scalability. Public block-chains, in particular, face limitations regarding transaction speed and network load. Aviation operations require real-time data processing, and block-chain systems need to overcome scalability issues to handle high volumes of transactions without introducing latency.
- Integration with Legacy Systems: Many existing air traffic management systems were developed long before block-chain technology emerged, making integration complex. ATSEPs and ANS providers will need to find solutions to bridge block-chain technology with legacy systems, potentially requiring significant infrastructure upgrades.
- Energy Consumption: Traditional block-chain consensus mechanisms like Proof of Work consume large amounts of computational power, raising concerns about energy efficiency. More energy-efficient consensus mechanisms, such as Proof of Stake or permissioned block-chain models, may need to be adopted for aviation-specific applications.
- omputational power, raising concerns about energy efficiency. More energy-efficient consensus mechanisms, such as Proof of Stake or permissioned block-chain models, may need to be adopted for aviation-specific applications.

Conclusion

Block-chain technology holds considerable promise for enhancing cybersecurity in ATSEP operations and air navigation services. By providing secure, immutable .

records, decentralized data storage, and encrypted communication channels, block-chain can transform how ATSEPs manage critical infrastructure and how air navigation services ensure system integrity and safetyWhile challenges such as scalability, integration with legacy systems, and energy consumption remain, the ongoing evolution of block-chain technology is likely to address these barriers. As air traffic becomes more complex and cyber threats evolve, the integration of block-chain could play a pivotal role in ensuring resilient and secure aviation systems for the future.

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Wired/Wireless Individual Light Control & Monitoring System (W-ILCMS) for Airports: Smart, Reliable, Real-Time Solution for CAT I/II/III compliance

(By W-ILCMS Project Team including PMC members from AAI and M/s Inxee)

Airports are bustling hubs of activity, where millions millions of aircrafts pass through every year. As such, effective lighting management is crucial for safety, energy efficiency, and enhancing the overall experience. The Wired/Wireless Individual Light Control & Monitoring System (W-ILCMS) offers airports an innovative solution to migrate their existing incompatible ALCMS to ILCMS and meet these demands, allowing for real-time monitoring and control of lighting across various area of airport. Under the AAI Start-up Initiative "Innovate for Airports" funded by the Ministry of Civil Aviation, Government of India, Indian Start-up M/s Inxee Systems Private Limited has developed indigenous Wired/Wireless Individual Light Control & Monitoring System (W-ILCMS) for Airports Authority of India.

What is Wired/Wireless Individual Light Control & Monitoring System (W-ILCMS)?

Indigenously developed system is capable for easy conversion of physical incompatible ALCMS to virtual unified ILCMS airfield lighting circuits. The Wired/Wireless Individual Light Control & Monitoring System is a smart lighting management solution that integrates advanced wireless and wired technology to monitor and control lighting based on specific needs of airports. In an airport setting, this system can manage lighting across runways, taxiways, apron area, parking stands and more, ensuring optimal visibility for safe navigation of aircrafts during the CAT I/II/III visibility conditions and enable smooth operations and maintenance of airport ground lights.

W-ILCMS KEY FEATURES:

- NO ADDITIONAL WIRING: One of the key features of W-ILCMS is to enable the existing ALCMS for ILCMS without additional HV cabling.
- DUAL MODE WIRED/WIRELESS CONNECTIVITY: Industry first solution with dual mode of wireless and wireless communication for reliable redundant data connectivity.
- REAL-TIME INDIVIDUAL LIGHT MONITORING: Airports can track the real time status of each airport ground light across multiple areas, helping identify faults and optimize the maintenance.
- CAT I/II/III SUPPORT: Suitable for meeting the operational requirements during the various CAT I/II/III visibility conditions.
- UNLIMITED VIRTUAL CIRCUITS: Airports can configure virtual light circuits according to operational requirements of the airport and CAT I/II/III visibility conditions.
- ENHANCED AIRFIELD SAFETY: Effective lighting is essential for safety in airports. W-ILCMS can ensure that critical areas, such as runways, taxiways, apron area etc, are adequately illuminated, improving the visibility for aircraft landing and guidance.
- INCREASED POWER SAVINGS: Airports are significant consumers of energy, and W-ILCMS can lead to substantial reductions in lighting-related costs. By adjusting lighting based on occupancy and time of day, airports can minimize waste and achieve significant energy savings.
- INCREASED SYSTEM RELIABILITY: Highly reliable solutions with redundant data communication to ensure 100% uptime of real-time operations of system.
- LAMP/CONNECTIVITY FAILURE ALARM: Advanced alarm system with real-time notifications for lamp failure/connectivity error enables maintenance team for prompt necessary actions.
- EASY INSTALLATION: Easy to integrate solution over the existing HV powerlines, enables hassle-free installation and reduces the work and effort required for installation.
- USER FRIENDLY CONTROL/MONITORING DASHBOARD: ATC and maintenance team can monitor and control airport ground lighting from central point, providing flexibility and quick responses to changing conditions.
- DATA ANALYSTICS: Comprehensive analytics tools can provide insights into lighting usage, helping airports identify opportunities for energy savings and operational efficiency.
- ICAO ANNEX 14 COMPLIANT: Designed in accordance with ICAO Annex 14 requirements.

W-ILCMS CONTROL AND MONITORING DASHBOARD

W-ILCMS SERVER FEATURES:

- Displays the status of individual lamps of the entire airfield lighting system, along with locations on the airport map
- Displays the fault/failure status of individual airfield lights
- Facilitates multiuser access to ATC and maintenance operators with single master mode access at a time for controlling individual or group lighting.
- Pre-configured lighting control mode based on various visibility and environmental conditions.
- Perform individual mode and group control mode to create multiple virtual circuits for various taxi options for aircrafts
- Graphical representation of individual lights and groups with real time power/alarm status for ease in monitoring a control for maintenance operators.
- Dedicated individual or group monitoring window for ease in monitoring by maintenance personnel.
- Data logger will log all airfield lighting events and alarm in the database.

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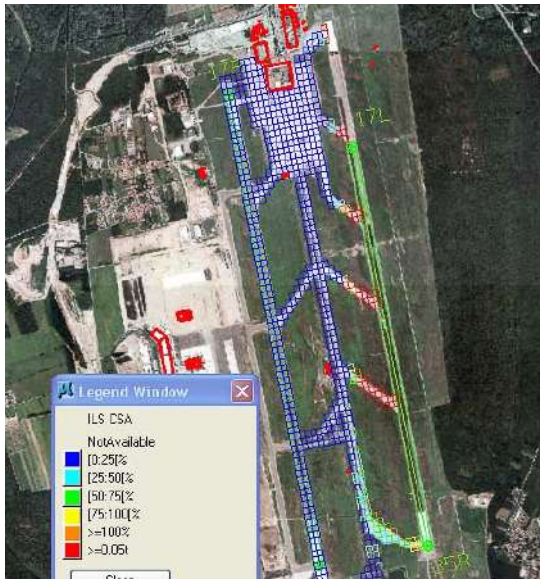
DGM (CNS), AAI, Guwahati

[Author of this article has more than ten years' experience on CNS Simulator (EMACS)]



CNS Simulator EMACS (Electro-Magnetic Airport Control Survey)

Aviation is the largest global transport system, connecting every corner of the world. Aircraft navigate across continents under the supervision of sophisticated technological systems installed both en route and at airports. The design of air routes and procedures considers factors such as distance, fuel efficiency, safety, and the coverage of Communication, Navigation, and Surveillance (CNS) facilities.

For Air Navigation Services (ANS) providers, selecting suitable locations for CNS facilities is crucial, following guidelines and siting criteria requirements, dictated by equipment design radiation pattern and operational regulations defined by regulatory authorities, such as the International Civil Aviation Organization (ICAO), DGCA CAR.

However, site selection for these systems poses challenges, particularly for ATSEP's (Air Traffic Safety Electronic Personals).

The complexity lies in assessing terrain conditions, and manmade structures along with other practical requirements. General requirements can be easily determined but the major difficulty is finding the optimal site based on terrain, ensuring sufficient coverage while avoiding interference.

Traditionally, ATSEP at the Airports Authority of India (AAI) would manually survey and calculate potential sites, but this approach was time-consuming and often lacked precision.

In today's era of advanced technology, simulation tools have revolutionized site selection. One such tool employed by ATSEP is EMACS (Electro-Magnetic Airport Control and Survey).

What is Simulation and Why it is Necessary?

Before moving forward on main topic, I would like to throw some light on Simulation and it's necessity.

Simulation, as a general term, is a process of imitating or representing a system or process in a controlled environment. It can involve creating models to represent the real world, and then running those models to see what could happens in a real system.

As aviation grows rapidly, there is an increasing need for fast, accurate, and advanced tools for planning a sustainable airport infrastructure along with the growth of city side development. EMACS serves as a vital resource for radio coverage and signal analysis assessments, helping to select appropriate sites and evaluate how new or existing infrastructure may affect CNS operations.

The Role of EMACS

EMACS not only aids in selecting the best sites for CNS facilities but also assesses the impact of both current and future airport infrastructure developments on the CNS environment. It helps airport planners or architects in the planning of world class airport infrastructure and passenger facilitation amenities.

AIS/AIM Automation System

As a leading ANS service provider Airports Authority of India, use AIS/AIM Automation system for modernizing its capabilities in the field of CNS Simulations, Aeronautical Information Services (AIS) publications and Flight procedure designing.

This system is an integrated platform used for all three functionalities as core components:

1. EMACS (Electro-Magnetic Airport Control Survey)
2. AeroPub (AIS Publisher)
3. FPDAM (Flight Procedure Design and Management)

EMACS: Performance Assessment of CNS equipment and Electro-magnetic Interference (EMI)

EMACS is a validated set of 3D electromagnetic modeling and simulation tools, designed to address issues like electromagnetic compatibility (EMC) and electromagnetic interference (EMI) at airports and air navigation sites. The tool models real-world propagation phenomena, accounting for terrain, obstacles, and both natural and man-made obstructions that can affect radio navigation signals.

How Does EMACS Work?

EMACS uses advanced computational electromagnetic techniques, such as:

- Geometrical Theory of Diffraction (GTD/UTD)
- Physical Optics (PO/PTD/ITD)
- Method of Moments (MoM)
- Deygout Method
- Parabolic Equations (PE)

The system is built on two main applications: First, Microstation (CAD software) for creating 3D models of airport infrastructure, and Second an electromagnetic environment (EM) application for simulating antenna placement and their EM behavior in the functional environment.

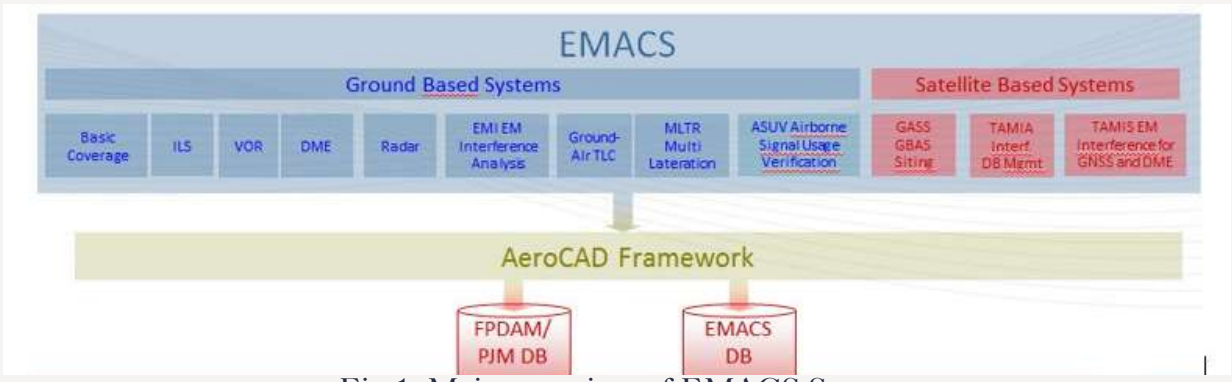


Fig 1: Main overview of EMACS System

See figure 2: An aircraft flying in a complex environment experienced all type of signals i.e. direct, reflected, blocking or shadowing. 360° assessment by a real flight for any CNS equipment is not possible and commercially viable solution. EMACS make it possible with its capabilities through computer and software applications.

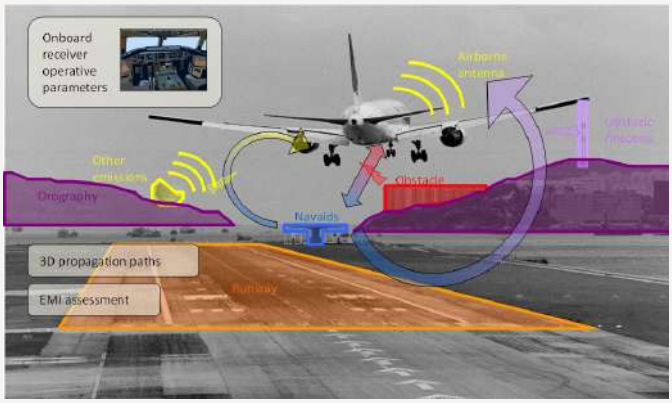


Fig 2: Aircraft under the guidance of CNS systems at an Airport also having multipath and EMI effect.

Terrain Management and Data Usage

EMACS uses SRTM terrain data with 30m, 90m and 900m resolution, depends on the type of simulation being carried out, freely available from EarthExplorer site which is maintained by NASA. The EMACS is also compatible to use terrain data acquired by ISRO for India. This data is crucial for radio coverage and signal analysis in complex terrain, especially in regions like India, which feature diverse and challenging landscapes.

Refer Figure-3 for a pictorial visualization of terrain profile and elevation values in the legend windows in different color representation. Figure 4 illustrates an airport surrounded by challenging terrain. The EMACS tool is employed to conduct simulation studies aimed at optimizing the placement and utilization of CNS equipment. By factoring in the elevation profile of the surrounding landscape, EMACS plays a key role in infrastructure planning. Through the integration of various software applications in EMACS, it enables detailed radio coverage and signal analysis for critical CNS systems such as Instrument Landing Systems (ILS), VOR, RADAR, NDB, Surface Movement Radar (SMR) etc. These simulations ensure that signal performance meets the standards set by regulatory guidelines, including DGCA CARs and ICAO Annex 10, Volume 1.

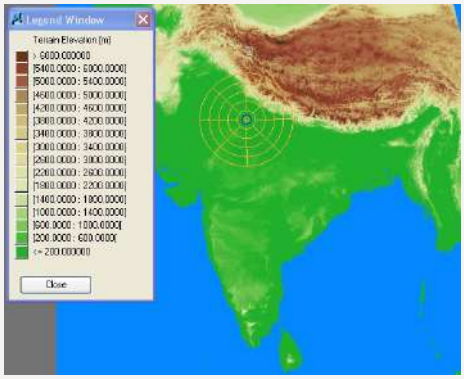


Fig. 3: Elevation profile example of terrain

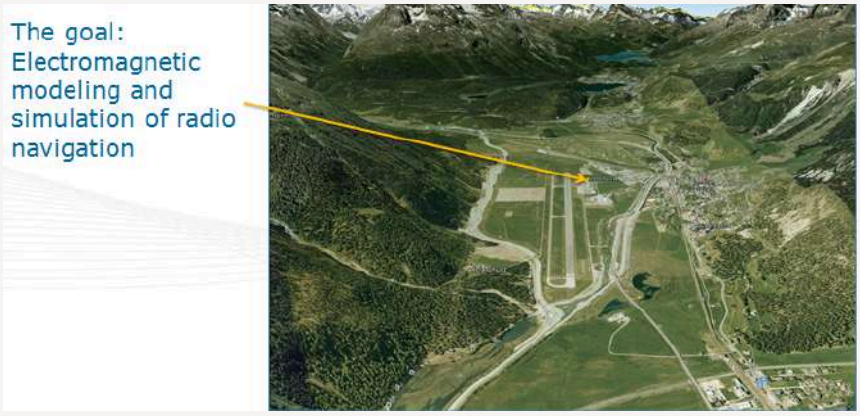


Fig. 4: An Airport surrounded by a difficult terrain is the best example for Simulation.

Simulation Types in EMACS

After obstacle modeling and antenna environment setup, EMACS performs various types of simulations, including:

- Radio Coverage Analysis
- DDM Analysis (ILS)
- EMI Analysis
- GPS Analysis
- Multi-Coverage Analysis (DVOR/DME/RADAR)
- DME-DME Analysis (RNAV Procedures)
- Ground-to-Air and Air-to-Ground Communication (TLC) Analysis
- Wind Turbine and MSSR Simulations (false target/OBA analysis)

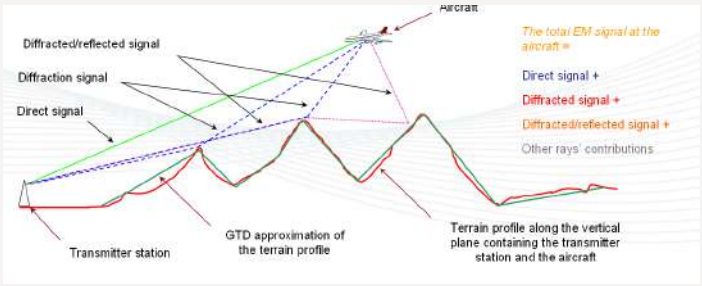
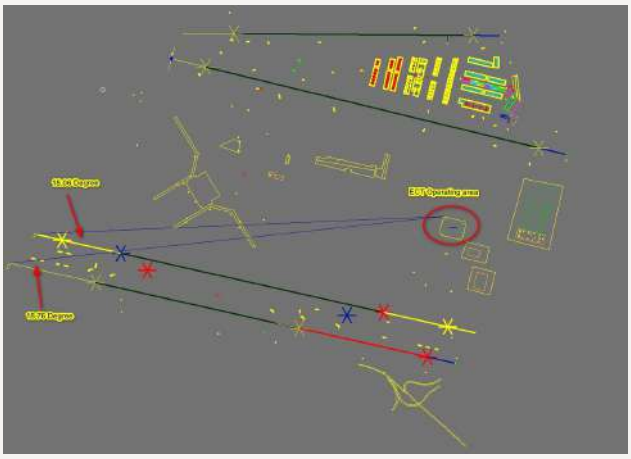


Fig. 5: An example of Terrain showing visibility and Multipath effect



· Fig. 6: A typical example of Obstacle modelling at Airport

Refer figure-6 for 3-D model of an airport and multipath impact on the course structure of ILS/Localizer for which the simulation analysis was carried out on EMACS.

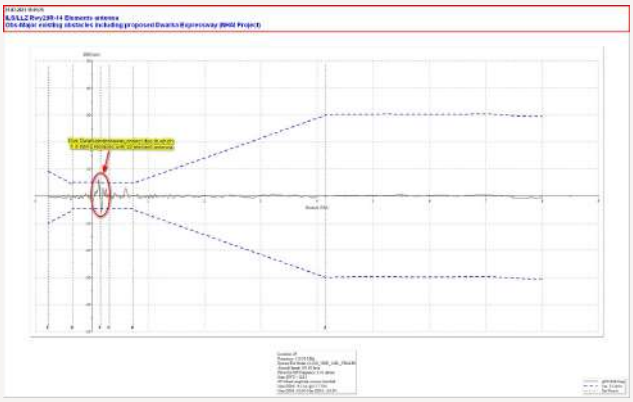


Figure: 7 Course structure of ILS/Localizer for CAT-III category limits

Applications of EMACS

1. Site Selection: EMACS is a vital tool for assessing the impact of infrastructure projects, such as ATC towers and terminal buildings, on CNS facilities. Height restrictions imposed by systems like the Localizer, VOR, and ASR/MSSR are evaluated using simulation studies as per GSR-751(E) guidelines from India's Ministry of Civil Aviation.
2. EMI Interference: In an electromagnetic environment, one transmitter's frequency can interfere with another, particularly in the VHF band. EMACS simplifies the assessment of such interference, allowing CNS engineers to evaluate and address these issues efficiently.
3. Multi-Radio Coverage Simulation: EMACS helps identify coverage gaps between multiple navigation aids or surveillance systems. Refer figure 8.
4. Wind Turbine Simulation: This feature analyzes how wind turbines affect systems like the VOR and SSR.

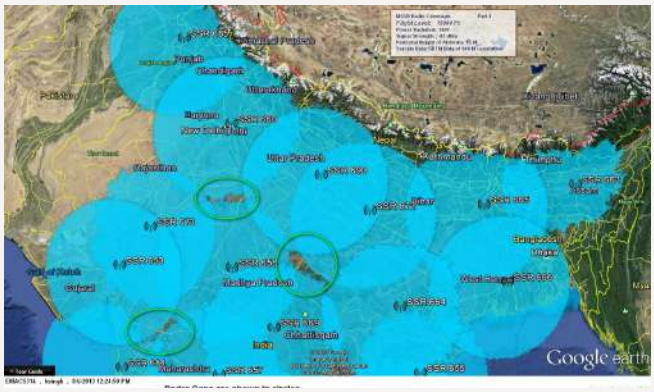


Figure:8 Multi-Radio coverage of RADAR

Pioneering Precision and Safety, Elevating Airports with Innovation and Expertise

Over the past 7-8 years, EMACS has successfully completed more than 500 simulation studies on various topics. These include NOCs for ATC towers, terminal buildings, cargo complexes, VHF masts, Apron Flood Light masts and hotel complexes etc. It has also been used for feasibility studies of CNS facility relocation, such as for the ILS in Mumbai and Chennai, and for identifying radio coverage gaps in Indian airspace.

The complete siting of CNS equipment's for under construction Jewar Airport, Navi-Mumbai Airport, Mandi Airport and more have been successfully done with EMACS only. Apart from this modernization of airport structure and its impact on CNS infrastructure is also the job work of this EMACS.

These achievements are a testament to the dedication of the ATSEP experts, engineers, and aviation professionals who tirelessly worked to deliver impeccable results.

As technology evolves, EMACS remains committed to advancing airport control solutions, embracing future challenges, and setting new benchmarks in aviation safety and efficiency.

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Keywords:
1. Very High Frequency Omni-range (VOR) – a radio navigational aid
2. Airport Surveillance Radar/ Monopulse Secondary Surveillance RADAR (ASR/MSSR)
3. Indian Reference Station (INRES) – part of satellite based navigation system GAGAN (GPS Aided Geo Augmented Navigation)
4. Shuttle Radar Topographic Mission (SRTM) - It is an international research effort that obtained digital elevation models on a near-global scale from 56° S to 60° N, to generate the most complete high-resolution digital topographic database of Earth

Creative Corner

कि त ना ना दा न है इं सा न ! !

खुशियाल सिंह,
उप-महाप्रबंधक(सी.एन.एस.)
क्षेत्रीय मुख्यालय, पूर्वोत्तर क्षेत्र
गुवाहाटी

कितना नादान है इंसान,
काटता है पेड़, मगर छाँव के लिए परेशान।
जिस कार की पार्किंग के लिए उजाड़
देता है पेड़,
उसी को धूप से बचाने के लिए ढूंडता है पेड़,
कितना नादान है इंसान

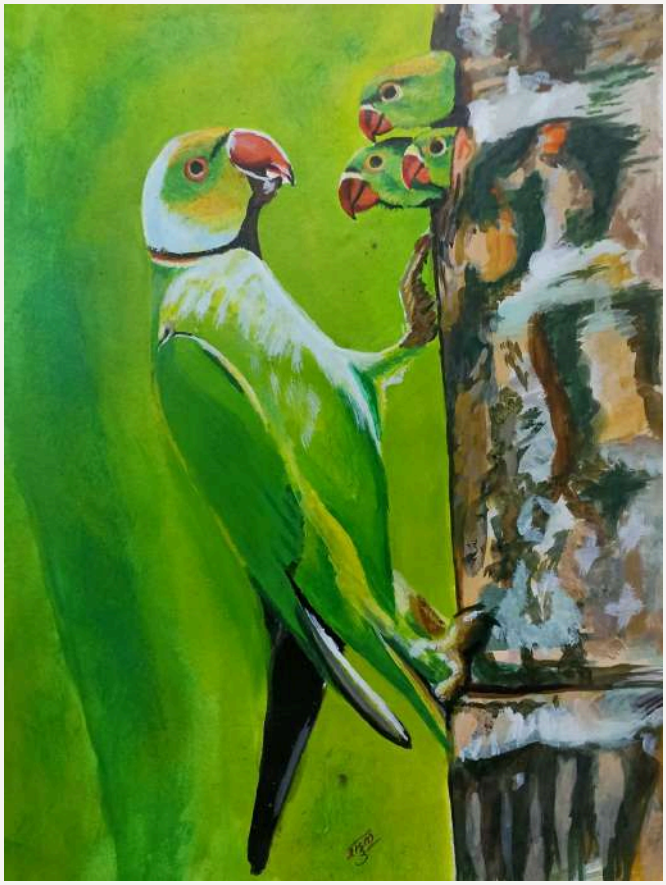
तालाब को पाटता, मकान बनाने को,
फिर पानी की कमी में, तड़पता है प्यास से।
कुदरत के खजाने को, खत्म करता बेहिसाब,
फिर सोचता है, काश बचाया होता ये ख्वाब।
कितना नादान है इंसान

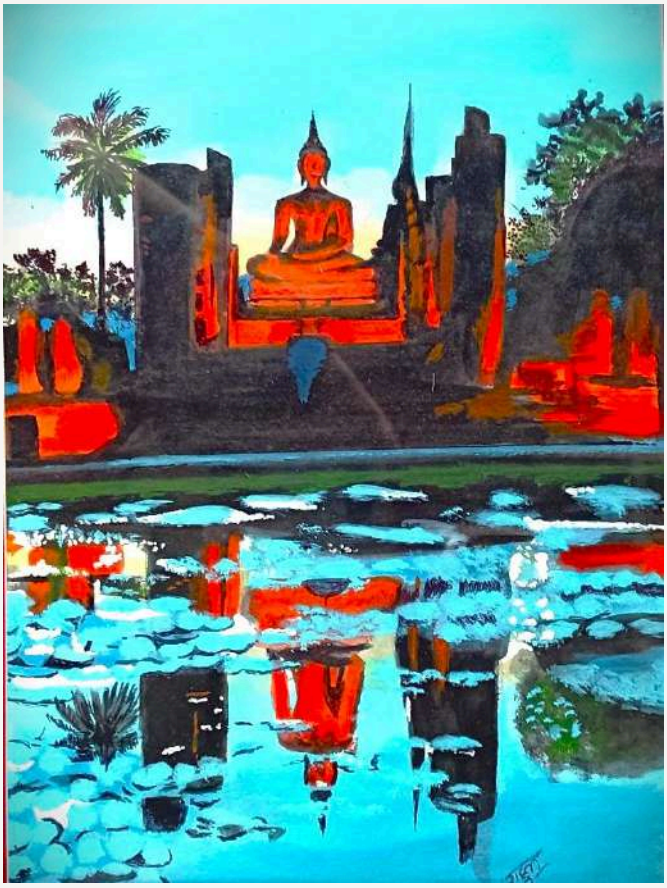
प्लास्टिक का करता है, बेशुमार इस्तेमाल,
फिर उसकी गंदगी से, खुद हो जाता है बेहाल।
धरती को दूषित कर, अपनी छवि बनाता,
फिर साफ़ हवा के लिए बेबस निहारता ।
कितना नादान है इंसान

संचार क्रांति के युग में मोबाइल को अपना साथी बनाता इंसान,
यू ट्यूब पर ही युटुब से बचने के उपाय खोजता इंसान,
समझता है सब कुछ, पर फिर भी बनता अनजान,
कुदरत की दौलत को मिटाने में समझता अपनी शान,
कितना नादान है इंसान

आओ हम सब मिलकर, एक नया सवेरा लाएँ,
कुदरत की दौलत की हिफाज़त करें, और उसे बचाएँ।
हरियाली को लौटाएँ, शुद्ध हवा बहाएँ,
फिर से एक सुंदर दुनिया सब मिलकर बनाएं।
फिर कोई कह नहीं पाए कि,
कितना नादान है इंसान ! कितना नादान है इंसान ! !

जिस दिन आसमान साफ़ होगा,
चंदा मामा के साथ ध्रुव तारा भी नजर में होगा,
आसमान में तारों की महफ़िल सजेगी,
जुगनुओं कि रौशनी रात के अँधेरे को हरेगी,
हर ओर उम्मीद की एक नई लौ नजर आयेगी.
फिर कोई नहीं कह नहीं पायेगा,
कितना नादान है इंसान !
कितना नादान है इंसान !!





Paintings by Rahul Chaudhary

Rahul Chaudhary
AGM (CNS), AAI-CHQ

Paintings by Kaayna

Kaayna, Class-X
Daughter of Sh. Ajay Kumar DGM
(CNS), AAI-CHQ

Goa, Where Every Sunset Tells a Story

Photographs clicked by Anil Kumar, Manager (CNS), AAI CHQ

Calangute Residency, Goa- Holiday Home-AAI

Calangute Beach Entry View, Calangute, Goa

cabo de rama beach

The Salaulim Dam

The Salaulim Dam

Anil Kumar,
Manager (CNS),
AAI CHQ

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