ICAO International Civil Aviation Organization
North American, Central American and Caribbean Office

Project RLA09801 – Technical Assistance Mission Meeting of the Surveillance Task Force (SURV) of the Air Navigation Services (ANS)

(Mexico City, Mexico, 13 to 15 July 2022).

Meeting Report

Prepared by the Surveillance Task Force Rapporteur

July 2022

Contents

References

- Annex 10 Volume IV "Volume IV Surveillance and collision avoidance systems"
- ICAO Document 9924 "Aeronautical Surveillance Manual" Third Edition (2020).
- ICAO Document 9863 "Airborne Collision Avoidance System (ACAS) Manual"
- ICAO Document 8643 "ICAO Aircraft Designators"
- ICAO Document 8585 "Designators for Aircraft Operating Agencies"

Objective

The objective of the technical assistance mission was to resume the work regarding the issues of the surveillance area of the NACC/WG/SURV Task Force, to support the States of the NAM/CAR region in the issues of implementation of systems surveillance, especially terrestrial and satellite ADS-B, as well as the contribution as a group to the regional objectives set forth through the North American, Central American and Caribbean Working Group (NACC/WG) and the GREPECAS projects.

1. Introduction

The surveillance group met at the ICAO Regional Office in Mexico City from 13 to 15 July 2022. The participants were identified between ICAO and the Rapporteur of the surveillance group based on their experience as regional specialists in the area, it was also attended by specialists from Mexico, who participated for the first time in this type of meeting.

The meeting participants worked together to ensure that the deliverables and topics of the work plan proposed for this meeting were fulfilled. The Working Plan is included in **Attachment A** to this report.

During this meeting, the participants focused on establishing the basis of the activities that have been planned to be developed in the next three years to harmonize the group's work with the requirements of the Global Air Navigation Plan (GANP) in its new version and support the regional objectives, as well as support for the development of the Electronic Air Navigation Plan (e-ANP) volume III.

In addition, support activities for the implementation of both terrestrial and satellite ADS-B were resumed, to ensure its correct and effective start-up, especially for those States that are in the process of implementing this technology.

The subject covered in this Report is the reflection of the discussions held among the participants, based on the information previously collected in the NAM/CAR States and in accordance with the regional objectives. This report provides a summary of each topic and the decisions made by the group that are reflected in recommendations and updating of the work plan of the NACC/WG/SURV Group.

Participants

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Navigation Services in the Mexican Air Space (SENEAM)
México

2. Issues addressed during the meeting

a. Regional implementation status of surveillance data

Through the analysis of the data received from the different States, it was possible to analyze the coverage status of the regional surveillance systems.

The information is presented the ***Attachment B*** to this document.

b. First version of the Document "Parameters to monitor the performance of ADS-B systems"

During the meeting, the draft of the document **"Parameters to monitor the performance of ADS-B systems"** was reviewed. The purpose of this document is to identify the general parameters to evaluate the performance of the Automatic Dependent Surveillance System – Broadcast (ADS-B OUT) and perform statistical analyzes of the ADS-B information provided by aircraft. The foregoing based on the need for constant monitoring required for the systems, use standardized criteria at the regional level to evaluate ADS-B data, define measurement levels, and standardize the same criteria for analysis of results.

The development of the document was based on the experience of Cuba, the United States and the Central American Corporation for Air Navigation Services (COCESNA). The Institute of Civil Aeronautics (IACC) of Cuba, began to carry out measurements and statistical analysis from the sensors that have been implemented since 2009 and since then they have evaluated the evaluation of the development of the ADS-B implementation.

The Federal Aviation Administration (FAA) of the United States has mandatory implemented the use of ADS-B since 1 January 2020, with which it has extensive experience in the implementation,

evaluation, monitoring and improvement of operations due to the statistical analysis it performs, work that began to develop arduously 10 years before its mandatory implementation.

COCESNA operates throughout the Central American Flight Information Region (FIR), has developed statistical analysis of surveillance data since 1999 and its evolution to ADS-B data analysis from 2006 to date.

The development of the document **"Parameters to monitor the performance of ADS-B systems"** is based on the experience obtained by the aforementioned States and organizations as part of the implementation and commissioning of surveillance systems in each of their States. , as well as the joint work with system providers in the use of software tools that allow the recording and analysis of surveillance data through the analysis of the Asterix protocol.

The first version of the document **"Parameters to monitor the performance of ADS-B systems"** can be found in **Attachment C** to this report.

The document will be presented at the NACC/WG/07 meeting with the objective that it be adopted by the region for the evaluation of data from its ADS-B stations, both at the test, pre-operational and operational levels, with The purpose of the document is to serve as a guide to evaluate the operating parameters of ADS-B and other surveillance systems.

c. Evaluation and applicability of ICAO Document 9924 "Aeronautical Surveillance Manual" Third Edition (2020)

The group discussed the evaluation and applicability of ICAO Doc 9924. It was determined that the new revision of the GANP will bring new information and recommendations on surveillance issues, especially in the area of Remote piloted aircraft system (RPAS). Based on this new revision that will be published before the end of the year 2022, the group decided to revise the document based on the new version of the GANP.

d. Evaluation of the recently published document the third edition of the Airborne Collision Avoidance System (ACAS) Manual (Doc. 9863)

In response to the evaluation of the Airborne collision avoidance system (ACAS) and the discussion of ICAO Doc 9863, it will be resumed after the approval of the new version of the GANP, since this is an ASBU element "ready to implement" and requires a prior evaluation to determine e level of regional implementation, as well as the applied state regulation.

During that discussion, the participants determined that the ACAS regulations of each State are not harmonized and that several States will have to generate a change to their regulations to accept ACAS X as a system of compliance with the standard.

It was determined that, in order to carry out the analysis, the group would need to:

1) Obtain information from each State on ACAS regulations.
2) Analyze the regulations, if they exist, of each State to determine which ones need changes.
3) Establish an ACAS implementation table and its evolution to the implementation of ACAS X.

Just as surveillance information was previously obtained from the NAM/CAR States, the ICAO NACC Regional Office will coordinate the collection of information from each of the States on ACAS implementation, regulation and operation. Once the information is available, an Ad-hoc team will analyze the data and the NACC/WG/SURV Task Force will provide the necessary recommendations to ensure that the States are harmonized as much as possible in their ACAS standards.

Ultimately, the group determined that ACAS-B2/2 on RPAS would be addressed when the next revision of the GANP is reviewed.

e. Evaluation of the "Ready to Implement" elements of the Global Air Navigation Plan, for the surveillance area

In addition to the ACAS elements in d), the group analyzed the ASBU elements below the ASUR ASBUs. A summary of each discussion and recommendation is included.

ASUR-B0/1 and B0/2

In order to be successful in implementing and publishing a standard for ADS-B, States will need to work closely with industry stakeholders. There is a need to work collaboratively to identify a feasible date for the implementation of ADS-B both operationally and in the publication of a regulation. Based on the lessons learned from States that have already implemented an ADS-B regulation, the group has generated the following recommendations:

Recommendation 1: ICAO States will work with stakeholders in determining an ADS-B equipment and implementation date.

Recommendation 2: States should take advantage of surveillance capabilities currently existing on aircraft, mainly ADS-B, and adopt the mandatory use of ADS-B as a regulation.

Recommendation 3: Take advantage of the use of ADS-B as the primary way to obtain aircraft parameters and complement the information using Mode S interrogations.

f. Establishment of the necessary bandwidth data for the different data to support the development of the terms of reference of the CANSNET communications network

In this matter, ICAO advised the Surv TF representatives of the request from the MEVA group to determine the bandwidth needed now, and in the future, to satisfy the data exchange of surveillance systems as part of the development of the Caribbean Air Navigation Services Network (CANSNET).

Participants discussed different processes that could be used to determine the bandwidth required for the future. The bandwidth needs were determined to vary based on:

1) The surveillance coverage area of interest of each State to cover the desired airspace.
2) Surveillance systems that exist in the airspace.

Based on this analysis, the group decided that the recommendations from the Surv TF group will be:

1) First integrate the necessary bandwidth to comply with what is currently established in MEVA.
2) Recommend that the requirements table change the channels to IP.

The Surv TF and ICAO will generate a table containing information on what data is currently being shared, and work with States to further identify areas of cooperation.

In addition, the COCESNA representatives took an action to determine the possibility of generating a working paper for the NACC WG/7 meeting to recommend a process for the exchange of surveillance data utilizing a surveillance communications server.

g. Establishment of support mechanisms for the development of the Electronic Air Navigation Plan, Volume III (e-ANP)

The group created a table to identify the percentage of airspace covered by surveillance systems, in addition to identifying which surveillance systems are being used to obtain the established coverage. ICAO will request that State's fill out the table, and utilize that information to generate a dashboard that will be maintained on the ICAO NACC website.

h. Updating of the Group's work plan to be presented at the NACC/WG/07 meeting for approval

The Group reviewed and modified the work plan identifying the projects that would result in better regional efficiency and harmonization. Appendix A contains the current Surv TF work plan that will be presented during the NACC/WG/07

i. Update of dates and activities of the subsequent phases of the GREPECAS Project

The Group updated the dates and activities of the GREPECAS project using the information in the table shown in Appendix A.

3. Recommendations

Based on the importance of the implementation of surveillance systems for aeronautical operations, it is recommended:

a) It is necessary for States to have surveillance systems to support their aeronautical operations.
b) That the States that have the necessary ADS-B infrastructure ready for their operations, implement the necessary regulations to ensure their operations in the short term.

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Attachment A

TASK NAME	Rationale	DELIVERABLE	DATE START	DATE END	RESPONSIBLE
Task Force Activities		ToR and Working Plan	01/2022	01/2025	TF Members
Revising and updating the Working plan	Ensure continuous re-evaluation of task force priorities.	TF Working Plan Updated	01/2022	01/2025	TF Rapporteur
Collect information on each State's current surveillance implementation	Determinar nivel de implementación de Sistema y cobertura de espacio aéreo. Identificar áreas de oportunidad para modernización o mejoramiento. En adición, utilizar la información para identificar grado de implementación y regulación de ADS-B.	Questionnaire	01/2022	08-2022	TF Members
Collecting and sharing statistics from ADS-B performance	Identify level of ADS-B equipage across the region. Assist in determining level of compliance to existing ADS-B regulations or as basis for development of an ADS-B regulation.	Statistics of ADS-B	01/2022	01/2025	TF Members
ADS-B parameters for monitoring performance in the airspace	Assist States in development of a tool to monitor ADS-B performance in the airspace.	ADS-B Parameters list	01/2022	08-2022	Cuba, US, Mexico, and COCESNA
Provide the Regional ConOps to ICAO SAM	Ensure harmonization in approach and implementation of ADS-B.	Regional ConOps	03/2022	03/2022	TF Rapporteur - Complete
Improve implementation of Data sharing	Leverage data sharing capabilities to improve quality of data.	Report of the Exchange	03/2022	01/2025	TF Members

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Attachment B

State	Surveillance Data	ADS-B Stations	ATM Integration	HMI support interface	Airborne System Version	Training	Technical Performance requirments	Regulations	Operational (yes/no)	Comment
Antigua and Barbuda	N	0	No	No	No	No	No	No	N	
Bahamas	Y	0	No	No	No	No	No	No	N	Proposed: 1 Radar A/C/S/ADS-B
Barbados	Y	2	Yes	Yes	No	No	No	No	N	Two MLAT with ADS-B
Belize	Y	1	Yes	Yes	V0,V1,V2	No	No	No	N	
Canada										
Costa Rica	Y	3	Yes	Yes	V0,V1,V2	No	No	No	N	
Cuba	Y	8	No	No	V0, V1 (6), V2 (2)	No	No	No	N	
Curacao	Y	0	No	No		No	No	No	N	Space based ADS-B not integrated with ATC system
Dominica	N	0	No	No		No	No	No		
Dominican Republic										
El Salvador	Y	1	Yes	Yes	V0,V1,V2	No	No	No	N	
Grenada	N	0	No	No	No	No	No	No	N	
Guatemala	Y	3	Yes	Yes	V0,V1,V2	No	No	No	N	
Guadalupe	Y	0	No	No	No	No	No	No	N	
Haiti	Y	0	No	No	No	No	No	No	N	Proposed: 1 Mode A/C/S Radar and 2 ADS-B

State	Surveillance Data	ADS-B Stations	ATM Integration	HMI support interface	Airborne System Version	Training	Technical Performance requirments	Regulations	Operational (yes/no)	Comment
Honduras	Y	3	Yes	Yes	V0,V1,V2	No	No	No	N	
Jamaica										
Martinique	Y	0	No	No	No	No	No	No	N	Radar SSR
Mexico	Y	10	No	Yes	V0,V1,V2	No	No	No	Y (1)	AFAC CO AV-91.2/19 (Aircraft)
Nicaragua	Y	3	Yes	Yes	V0,V1,V2	No	No	No	N	
Saint Kitts and Nevis										
Saint Vincent and the Grenadines										
Saint Lucia	N	0	No	No	No	No	No	No	N	Plan ADS-B
Trinidad and Tobago	Y	1	Yes	No	No	No	No	No	N	Radar SSR
United States	Y	710	Yes	Yes	V2	Yes	Yes	Yes	Yes	

ATTACHMENT C

PARAMETERS TO MONITOR THE PERFORMANCE OF ADS-B SYSTEMS

FIRST EDITION, JULY 2022

Approved by the ICAO NACC Regional Office for use in the CAR region

INTERNATIONAL CIVIL AVIATION ORGANIZATION

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ICAO NACC

PARAMETERS TO MONITOR THE PERFORMANCE OF ADS-B SYSTEMS

FIRST EDITION

MEXICO

JULY 2022

Disclosure

This document has been developed by members of the Surveillance Task Force (NACC/WG/SURV), part of the North American, Central American and Caribbean Working Group (NACC/WG) based on the ADS-B implementation and monitoring experience in the NAM/CAR region and for use by CAR States.

CONTENT

AMENDMENTS

No	DATE	DESCRIPTION

1 GLOSARY

ADS-B: Automatic dependent surveillance - broadcast

ADS-B OUT: automatic dependent surveillance – broadcast

ANSP: Air Navigation Service Provider

ASTERIX: All-purpose structured Eurocontrol radar information exchange IP/UDP: Internet protocol/User Datagram Protocol

NTP: network time protocol

SAC: Fields System Area Code

SIC: System Identification Code

UAP: User Application Profile

2 INTRODUCTION

2.1 The purpose of this document is to identify the general parameters to evaluate the performance of the Automatic Dependent Surveillance - Broadcast (ADS-B OUT)[1] and to perform statistical analyses of the ADS-B information provided by aircraft using a performance monitoring system.

2.2 The above-mentioned is based on the following needs:

a) Permanently, periodically and automatically monitor the performance of the ground and/or satellite-based ADS-B systems, as well as the information provided by the aircraft, ensuring compliance with the requirements established by the States for the use of ADS-B in its defined airspaces in accordance with its procedures and systems to guarantee operational safety.

b) Use minimum standardized criteria to perform ADS-B statistical analyses, including technical and operational criteria based on the requirements of each airspace.

c) Use ADS-B performance levels to filter data based on the different parameters to be measured.

d) Allow a common language of interpretation of the criteria and results of the statistical analysis of the ADS-B.

e) Identify the items required for statistical analysis; and

f) Support technical-operational decision-making.

2.3 The information collected may provide air navigation providers (ANSP), requesting aircraft, aircraft owners, operators, and companies responsible for installing and maintaining on-board equipment of statistical information on the capabilities, performance and data of position received by ground- or satellite-based ADS-B receivers, as an additional method of verifying the proper operation of the related ADS-B and on-board navigation systems.

[1] ADS-B OUT: Automatic Dependent Surveillance – Broadcast system is a function in an aircraft or vehicle that periodically transmits its vector state (position and speed) and other information derived from airborne systems in a format suitable for ADS - B IN. ICAO Doc 9924.

2.4 The data is useful to air navigation providers to monitor aircraft capabilities, conduct research and support with safety case analyses, and to aircraft avionics maintainers to perform post-installation and isolation conformance/configuration checks of failures.

2.5 Examples of existing ADS-B performance monitors created by Cuba, United States and COCESNA can be found in Appendix A, Appendix B and Appendix C of this document.

3 REFERENCE DOCUMENTS

[1]. Annex 10, Aeronautical Telecommunications; Volume II, ICAO Communication Procedures, 7th Edition, July 2016.

[2]. EUROCONTROL Specification for ASTERIX Surveillance Data Exchange, Part 12 Category 021, ADS-B Target Reports, 22 December 2021.

https://www.eurocontrol.int/sites/default/files/2021-12/asterix-adsbtr-cat021-part12-v2-6.pdf

[3]. Specification for Surveillance Data Exchange – Part 16 - ASTERIX (CNS/ATM Earth Stations and Station Status Reports) Cat 023, Edition 1.3, 27 September 2021.

https://www.eurocontrol.int/sites/default/files/content/documents/nm/asterix/cat023-asterix-cns-atm-ground-station-service-messages-part-16.pdf

[4]. Minimum operational performance standards for 1090 MHz Automatic Dependent Surveillance - Broadcast (ADS-B), EUROCAE ED-102A/RTCA DO-260B) RTCA/EUROCAE January 2012.

4 DATA RECORDING

4.1 The system should allow real-time data recording of ADS-B Version 0, 1 and 2 messages, received in Asterix CAT[2] 021 edition 0.23, 2.1, 2.4 and/or 2.6 format. Version 0.23 only allows formatting Version 0 messages and from edition 2.1 it is possible to additionally format versions 1 and 2. In the case of version 2.6 it will allow formatting ADS-B messages, Version 3. The recording must be done in the version that the server processes the surveillance data of the Control Centre Automation system.

4.2 Cat. 23 will be used to determine the technical status of each of the ground or satellite stations.

4.3 The system must process and decode all the fields and data items of the standard UAP (User Application Profile) for Asterix Cat. 21 and Cat. 23 in the latest implemented edition.

4.4 Data recording should be done over LAN, using IP/UDP and Unicast/Multicast protocols over redundant networks.

4.5 Each message should identify the ground and satellite based ADS-B sensor through the System Area Code (SAC) and System Identification Code (SIC) fields of the Asterix message. In the case of multiple ADS-B sensors, a server may be required to merge the information received.

NOTE: The SAC is established for each of the States at the following address:

https://www.eurocontrol.int/asterix

The SIC is established by the authority of each civil aviation of each State.

4.6 Both terrestrial and satellite-based systems and recording servers will need to be synchronized with Network Time Protocol (NTP) clocks for data formatting and data latency determination.

[2] CAT: Category

4.7 Recordings should be made continuously. Once the recording is finished and the data has been processed by the system, it should be available to users to generate the queries that are required from a suitable interface.

NOTE: Each state has to define the configurable recording time interval and data backup time.

5 GENERAL FILTERS FOR QUERIES

Queries or reports should be generated from the following information:

FIELD	DESCRIPTION
24-bit ICAO address:	Unique six-character ICAO 24-bit hexadecimal address assigned to an aircraft at the time of registration. The ICAO code is the same as the Mode S address.
Flight ID or aircraft registration:	Unique number assigned to the flight (call sign/registration), it should coincide with the call sign of the aircraft used in ATC communication. The air carrier could be identified for commercial aviation.
Mode A code:	Received by the aircraft in octal format and assigned by ATC
Emitter Category:	Indication of aircraft characteristics (type/size/weight/performance), important to identify wake turbulence.
Start time:	Time of the first monitored report of the flight in UTC time.
Ending time:	Time of last flight report in UTC.
Start date:	Flight starting date.
Aircraft location area	Select area of interest/volume of airspace.

NOTA: It should be related by means of the ICAO address, the aircraft registry and the make and model of the ADS-B and GPS transmitter. Related information should include aircraft type and model (see DOC 8643) and operators (see DOC 8585).

6 GENERAL SPECIFICATIONS OF ADS-B DATA PROCESSING

6.1 The system must have the capacity to process and identify all versions of ADS-B (DO-260, DO-260A, DO-260B and the new version DO-260C), with the correct processing of the figures of merit for each version[3].

6.2 The system shall process WGS-84 position data including high resolution, geometric height, flight level and enhanced aircraft intent information for each message.

6.3 Decode the different identifications of the aircraft: ICAO 24-bit address, flight ID, Mode 3/A and emitter category.

6.4 For each report, the different times of the message will be stored: time of reception of the position and speed, time of applicability of the position and speed, including the times of high precision of the message.

6.5 For each report, the UTC date and time of recording of the message is stored for the purpose of performing message latency analysis.

6.6 The system must process the aircraft status fields, the aircraft report description fields, ACAS resolution, and the power amplitude of the message.

6.7 Data should be collected and identified for the following phases of flight whenever there is coverage of ADS-B receivers:

a) 1090 – In the air

b) 1090 – On ground

The surface information depends on whether a service volume covered by a ground- or satellite-based ADS-B receiver exists.

6.8 Identify the capacity or type of transmitted link for the ADS-B capacity (1090). The 1090ES is the standard used internationally and recommended by the ICAO. Using UAT is not recommended.

6.9 Process and store for each message the following figures of merit according to the version of the ADS-B standard, identifying the messages that do not comply with the criteria or rules defined for each State:

[3] The versions of ADS-B, Version 0, 1, 2, and 3, refer to the DO-260, DO-260A, DO-260B, or DO-260C operational performance standards that were used by avionics manufacturers.

a) NACp (Navigation Accuracy Category for Position): This field indicates the accuracy of the position of the aircraft being transmitted.
b) NACv (Navigation Accuracy Category for Velocity): This field indicates the navigation accuracy for the velocity of the aircraft being transmitted.
c) NIC (Navigation Integrity Category): The NIC coding is used to indicate the containment radius around the aircraft.
d) SDA (System Design Assurance): Measures the probability of incorrect data being sent.
e) SIL (Surveillance/Source Integrity Level): Measurement of the probability of not being within the containment radius.
f) SILs (Surveillance/Source Integrity Level Supplement): This is a one-bit field that informs the system if the SIL is administered per hour or per sample. It is not considered a priority parameter.
g) SQL (Signal Quality Level): Measurement of the integrity of the data sent.

6.10 Identification of the classes of airspace in which the aircraft operated during the flight, as long as the system allows the processing of geographic information and the airspaces are defined.

6.11 Define and configure different types of performance rules depending on the ADS-B version and the combination of Figures of Merit (for example, NIC, NACp, etc.) and airspace.

6.12 Duration of the flight in the different reports, must indicate the total flight time measured in hours, minutes and seconds.

6.13 Calculate the availability and reliability of the ADS-B surveillance sensor, taking into account the information on the status of the ground station provided in Asterix CAT 023, which indicates when the information provided can be used for operational use.

6.14 Process the other fields of the UAP Standard CAT 21 and CAT 23 according to the implemented version.

7 PERFORMANCE EVALUATION OF ADS-B SENSORS

The system must allow the evaluation of the general performance of the ground- and/or satellite-based ADS-B systems independently and using multi-sensor information, which allows the determination of the following parameters:

a) Total ADS-B reports
b) Average update rate of ADS-B reports in seconds
c) Update Probability (Pd) in general and by aircraft, according to the volume of traffic and type of airspace.
d) Probability of false targets
e) Mode A code detection probability
f) Mode C code detection probability
g) Size of the maximum and average gaps
h) Unassociated reports

NOTE: Target information does not correspond to other aircraft information (eg: flight plan).

i) Position error (RMS)
j) Latency
k) Availability based on the operational status of the sensors.
l) Maximum, minimum and average time delays of communications.
m) Coverage based on opportunity traffic, multi-sensor track and terrain elevation information.

8 STATISTICS GENERATION

The system through a user interface must allow the generation of the following statistics:

a) Total number of ASTERIX ADS-B messages historically processed by the system.
b) Number of aircraft with ADS-B capability filtered by date and time.
c) Number of operations with ADS-B capacity per day.
d) Percentage of aircraft with a different ADS-B version (DO-260, DO-260A, DO-260B or DO-260C). The number of aircraft with erroneous versions must be identified.
e) Percentage of aircraft according to the value of each figure of merit.
f) Percentage of aircraft that comply with the performance rule established for each airspace.
g) Additionally, the system must use filters to obtain flight information according to date, time and selectable fields.
h) Aircraft trajectory reports.

9 PROBLEM REPORTS

The system should make it possible to identify, for the different flights, common problems of erroneous information and poor ADS-B performance in order to carry out risk analysis, identify their possible causes and mitigate them. Such reports should include the following:

a) Number and size of intervals due to loss of message during the flight or with data interruption.
b) List of aircraft and duration of the flight in which erroneous information was transmitted.
c) List of aircraft and duration of the flight with wrong or missing identification (aircraft ID) due to not being configured in the avionics. Including aircraft where the three-letter operator identifier is missing.
d) List of aircraft and flight duration with mode 3/A identification assigned, during the entire flight or part of it.
e) List of aircraft and flight duration with an incorrect ICAO 24-bit address or duplicate address.
f) List of aircraft and duration of the flight with the emitter category missing or not configured in the avionics.
g) List of aircraft and flight duration with missing figures of merit or with NIC, NACv, NACp, SIL and/or SDA category problems.
h) List of aircraft and duration of the flight in which the ADS-B rule was breached. The ADS-B rule defines a combination of required figure of merit values.
i) List of aircraft and flight duration with inconsistent ADS-B version and reported figure of merit value.
j) List of aircraft and flight duration with loss of data from the barometric pressure altitude source (BARO ALT).
k) Lists of aircraft and flight duration with loss of geometric altitude data (GEO ALT).
l) List of aircraft with inconsistency in the reported flight phase (In Flight or Surface)
m) List of aircraft in ACAS resolution.

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ICAO Regional Office for North America, Central America and the Caribbean

Communications, Navigation and Surveillance.

Appendix A

Cuba ADS-B Analysis Tool

Cuba has developed through the Institute of Civil Aeronautics of Cuba (IACC) a Software that contains two applications that provide monitoring and statistical analysis of Radar Surveillance Systems.

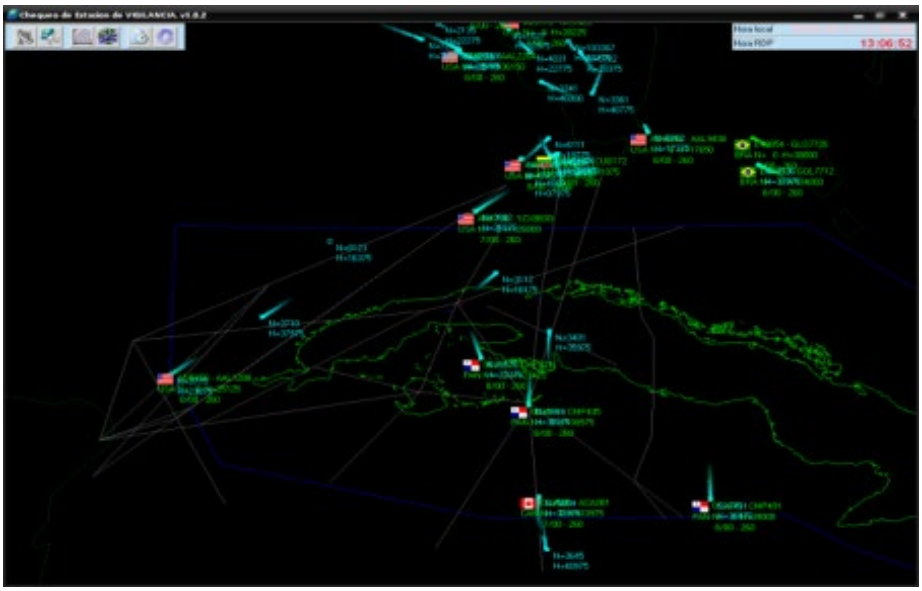
The tool is operating in Cuba and Mexico.

1. **SurvSENSOR App:**

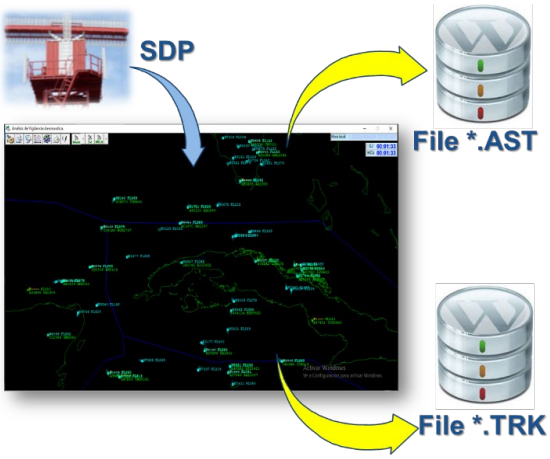
Application that receives data from aeronautical surveillance sensors (RADAR, ADS-B and/or MLAT) in ASTERIX format through a communications channel (RS-232, Ethernet UDP). Description of the system for the statistical analysis of Cuban aeronautical surveillance data.

The system developed in C++ consists of two applications with the following functionality:

Application that receives data from aeronautical surveillance sensors (RADAR, ADS-B and/or MLAT) in ASTERIX format through a communications channel (RS-232, Ethernet UDP).



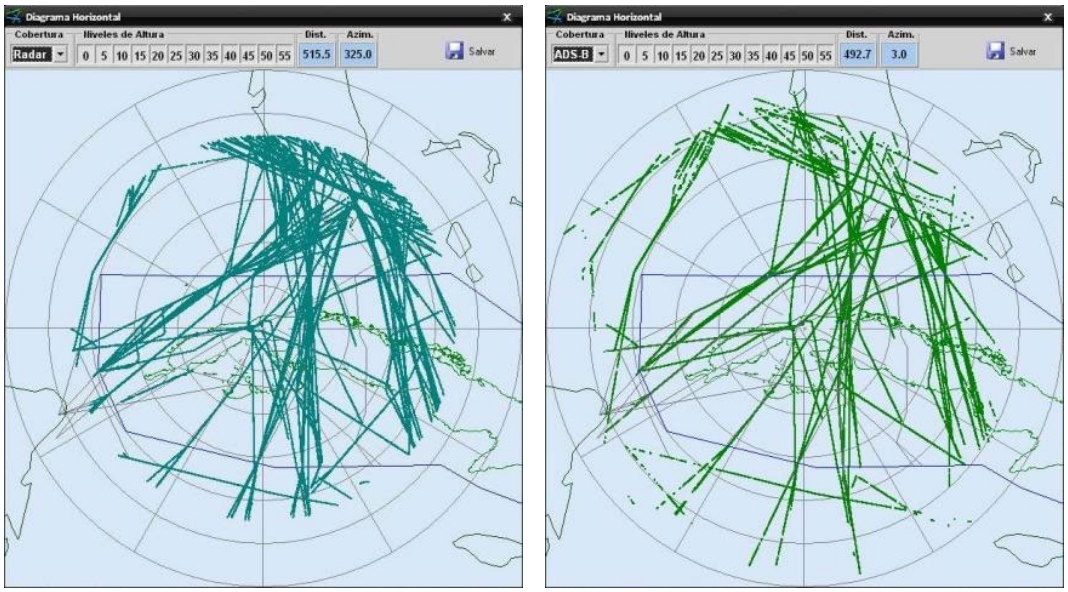
SurvSENSOR has the functionality of representing, storing, and processing the information received, allowing in addition for the retransmission of the information.



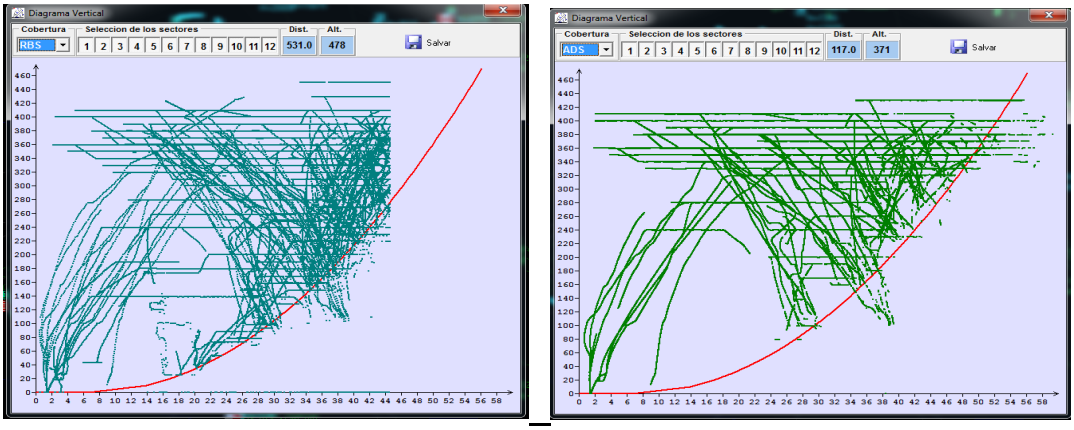
First, a constant monitoring of the technical status of each of the coupled sensors is carried out, allowing to determine their operational status, calculating availability and reliability over time.

It calculates the number of bytes per second received by the data from each sensor having a reference of the channel bandwidth.

It contains the possibility of performing a horizontal and vertical coverage analysis, both as an independently coupled sensor and as a multi-sensor analysis.

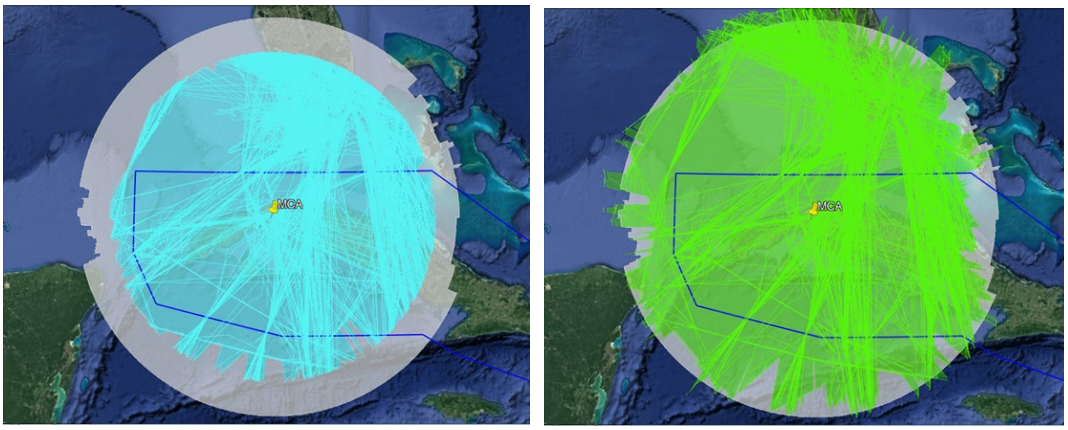


Horizontal Coverage. (a) RADAR (b) ADS-B.



Vertical Coverage. (a) RADAR (b) ADS-B.

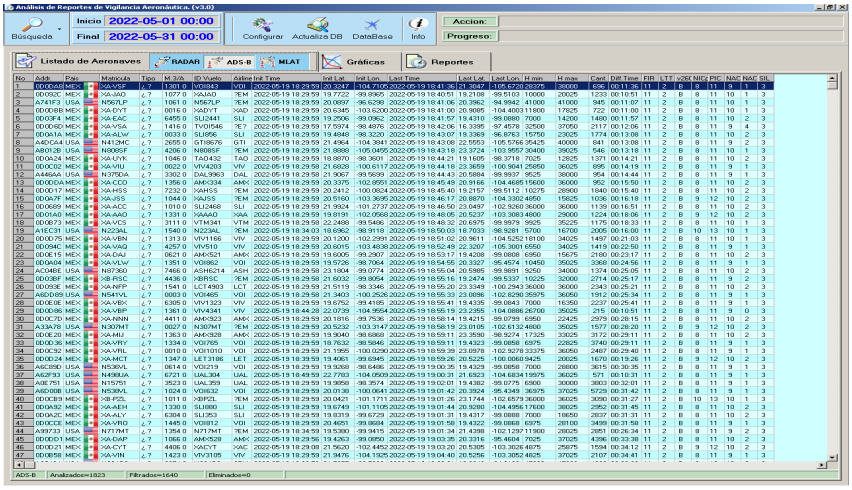
Having the representation of the real coverage of the detected data, the information can be correlated with the calculated theoretical coverage of each sensor at a determined flight level as shown in the following figure, making it possible to determine the possible zones of low or null probability of detection.



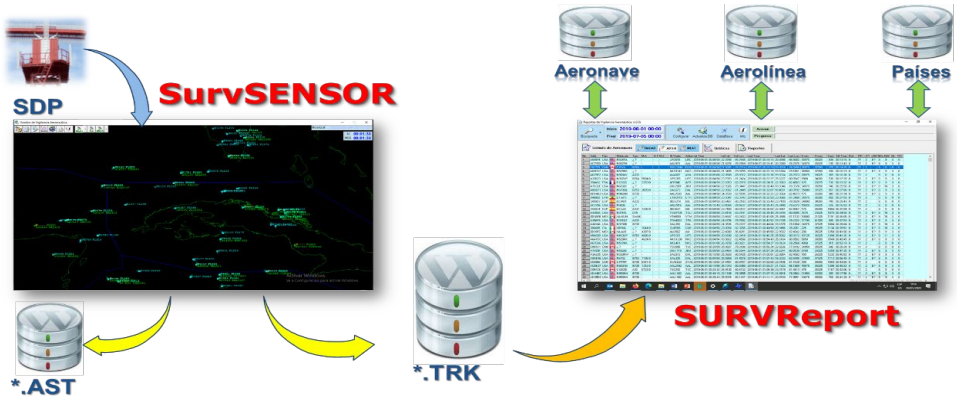
Correlation between theoretical and actual coverage. (a) RADAR (b) ADS-B.

2. SurvReport Application:

The application that statistically analyzes the information processed and stored from the SurvSENSOR application.



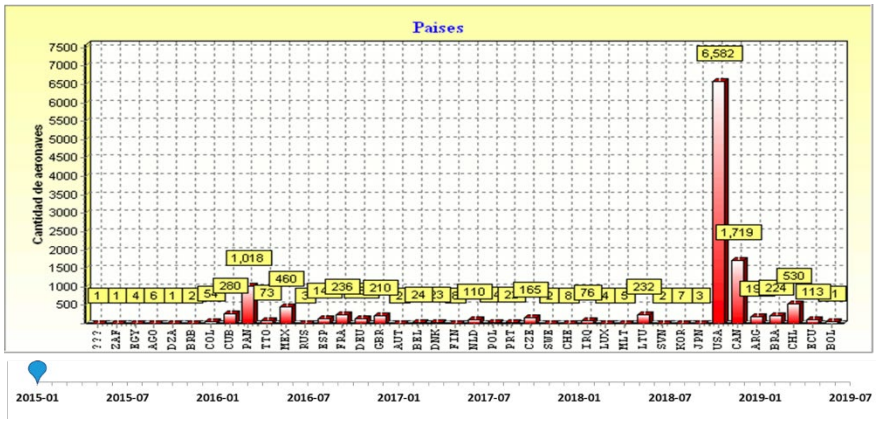
SurvREPORT has the functionality of processing, storing, correlating, and creating different statistical analysis reports of the aeronautical surveillance data, generating a list and/or graphic.



First, a search is conducted in the stored data (TRK) with a filter of the parameters of a time interval, specific region, flight level, identification code, 24-bit mode S code, flight identification, and quality parameters (e.g., ADS-B: version, NIC, NACp, SIL). The search criteria is fully configurable, and are used for the processing that will define the tracking of each aircraft, allowing a quantitative assessment of the aircraft detected by each surveillance system.

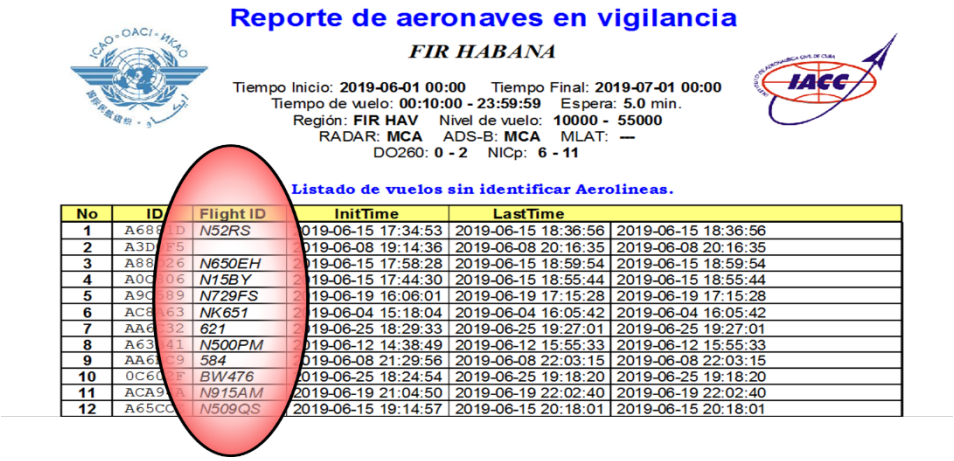
This application allows a correlation to be made between the data received by the different surveillance systems, whether RADAR, ADS-B, and/or MLAT within a given region, calculating the percentage of aircraft detection between the different surveillance systems.

A correlation of the filtered data between the 24 bit Mode S address data with the database of the countries (Annex 10, Vol III, Table 9-1. Attributions to the States of aircraft addresses), the base data from registration records and the aircraft type designator (Doc 8643), identifying the countries, registrations, and the type designator of each aircraft.



Country Correlation

The correlation between the flight identifier (FlightID) and the airline registry (Doc. 8585) is also accomplished, allowing for identification of the airline for the specific flight or the possible errors in the inputting of the FlightID data.



Reporte de aeronaves en vigilancia

FIR HABANA

Tiempo Inicio: **2019-06-01 00:00** Tiempo Final: **2019-07-01 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **5.0** min.
Región: **FIR HAV** Nivel de vuelo: **10000 - 55000**
RADAR: **MCA** ADS-B: **MCA** MLAT: **—**
DO260: **0 - 2** NICp: **6 - 11**

Listado de vuelos sin identificar Aerolineas.

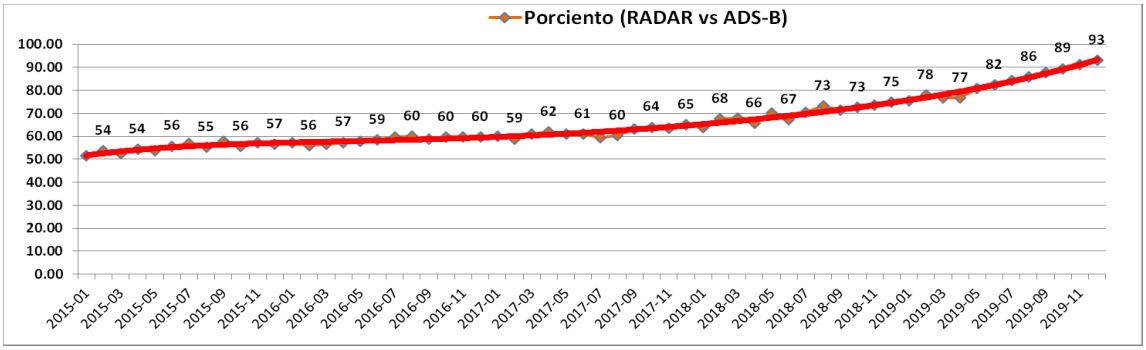
No	ID	Flight ID	InitTime	LastTime	
1	A688[illegible]D	*N52RS*	019-06-15 17:34:53	2019-06-15 18:36:56	2019-06-15 18:36:56
2	A3D[illegible]F5		019-06-08 19:14:36	2019-06-08 20:16:35	2019-06-08 20:16:35
3	A88[illegible]26	*N650EH*	019-06-15 17:58:28	2019-06-15 18:59:54	2019-06-15 18:59:54
4	A0C[illegible]06	*N15BY*	019-06-15 17:44:30	2019-06-15 18:55:44	2019-06-15 18:55:44
5	A9C[illegible]89	*N729FS*	019-06-19 16:06:01	2019-06-19 17:15:28	2019-06-19 17:15:28
6	AC8[illegible]63	*NK651*	019-06-04 15:18:04	2019-06-04 16:05:42	2019-06-04 16:05:42
7	AA6[illegible]32	*621*	019-06-25 18:29:33	2019-06-25 19:27:01	2019-06-25 19:27:01
8	A63[illegible]41	*N500PM*	019-06-12 14:38:49	2019-06-12 15:55:33	2019-06-12 15:55:33
9	AA6[illegible]C9	*584*	019-06-08 21:29:56	2019-06-08 22:03:15	2019-06-08 22:03:15
10	0C6[illegible]F	*BW476*	2019-06-25 18:24:54	2019-06-25 19:18:20	2019-06-25 19:18:20
11	ACA9[illegible]A	*N915AM*	2019-06-19 21:04:50	2019-06-19 22:02:40	2019-06-19 22:02:40
12	A65C[illegible]	*N509QS*	2019-06-15 19:14:57	2019-06-15 20:18:01	2019-06-15 20:18:01

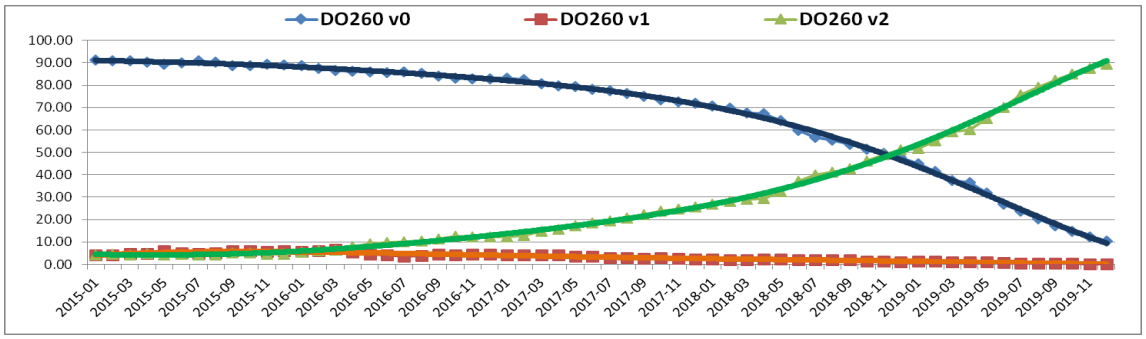
It is possible to create a list of the aircraft that do not comply with a determined set of criteria or airspace regulation by the user (e.g., NIC >= 7, NACp >= 8).

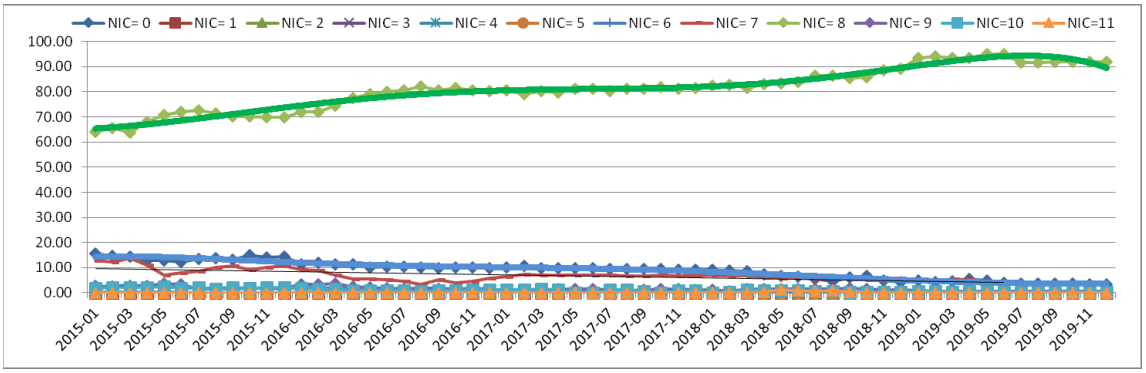
From the conception of the applications explained above, a web interface was not developed since both applications are installed in a closed network environment having only connectivity with the sensors, restricting the ability to create an interface. The export of the results in the form of statistical analysis reports generated by the user is done in PDF format.

3. Statistical Analysis of the generated results.

From 2015 to 2020, the statistical analysis of the surveillance data was carried out, on a monthly basis, comparing the data between RADAR and ADS-B, demonstrating the evolution that the different versions and quality parameters of ADS-B systems has introduced over these years.





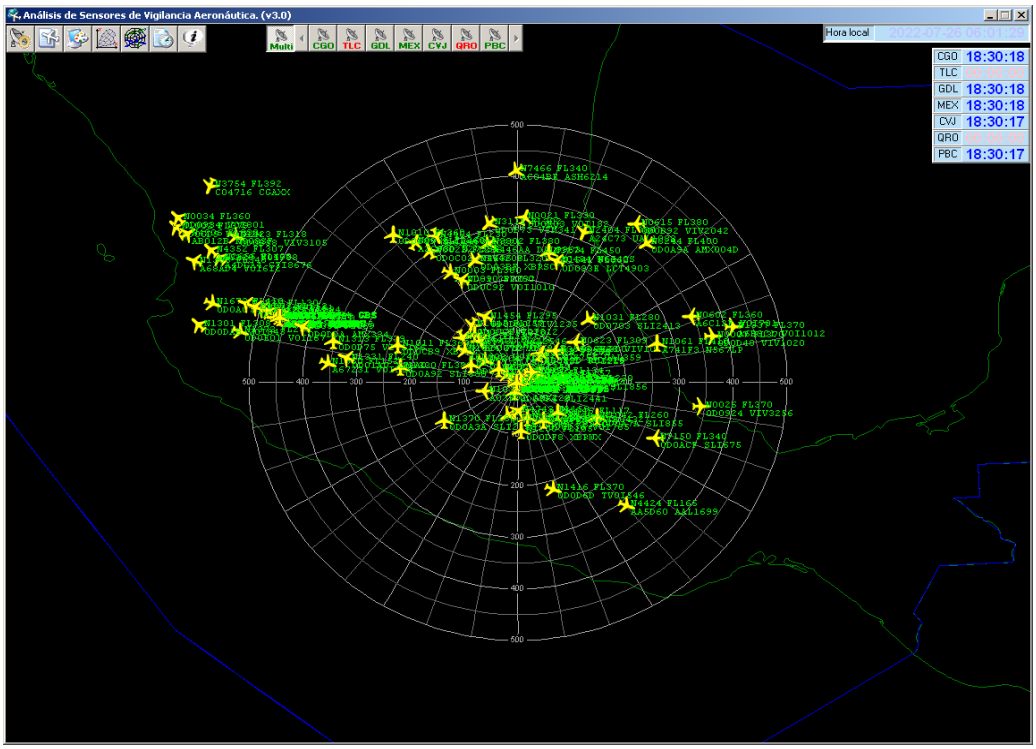


It has been shown in this analysis:

- A sustained growth of aircraft with ADS-B message transmissions.
- A decrease in transponders with the DO-260 / DO-260A versions, and an increase in the DO-260B Version.
- The predominant Navigation Integrity Category (NIC) is NIC =8.
- The predominant Navigation Accuracy Category (NAC) is NACp=9.
- Different errors and inconsistencies have been detected in the information correlation of the 24-bit Mode S codes.
- A high percentage of errors has been seen related to user input of the flight identification parameter on board the aircraft, not allowing the determination of the airline to which the flight belongs when the flight identification does not correspond to the registration.

4. **Collaboration and installation project in Mexico's Air Traffic Control Center (AFAC – SENEAM 2022-05)**

In May 2022, through a collaborative project with AFAC-SENEAM, the statistical analysis tool was installed in Mexico, coupling several ADS-B sensors detecting the ADS-B message transmissions in a region of Mexico's FIR.



This scenario was fundamental for testing the stability of the system due to the high volume of available information.

The system continues to be dynamically developed with new possibilities arising from this collaborative project.

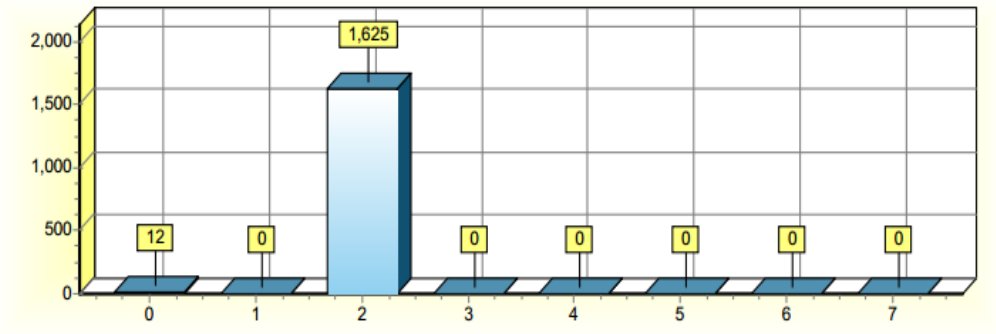
Below are examples of reports of the statistical analysis for some of the parameters.

Reporte de Sistemas de Vigilancia

FIR México

Tiempo Inicio: **2022-05-01 00:00** Tiempo Final: **2022-05-31 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **20.0** min.
Región: **---** Nivel de vuelo: **10000 - 55000**
Cobertura RADAR: **---** ADS-B: **---** MLAT: **---**
M3/A: **0000 - 7777** Addr: **000000 - FFFFFF** ID:
DO260: **0 - 7** NICp: **6 - 11** NACp: **0 - 15** NACv: **0 - 7** SIL: **0 - 3 (Ave)**

Análisis por versión DO-260.



Análisis de los datos según versión DO-260

Parámetros	Cantidad	Porciento
DO-260 = 0 :	12	(0.7%)
DO-260 = 1 :	0	(0.0%)
DO-260 = 2 :	1625	(99.1%)
DO-260 = 3 :	0	(0.0%)
DO-260 = 4 :	0	(0.0%)
DO-260 = 5 :	0	(0.0%)
DO-260 = 6 :	0	(0.0%)
DO-260 = 7 :	0	(0.0%)
Filtro :	**1637**	

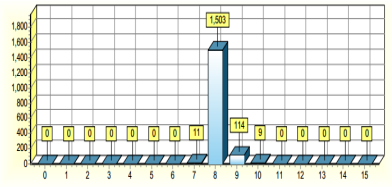
DO-260 Version

Reporte de Sistemas de Vigilancia

FIR México

Tiempo Inicio: **2022-05-01 00:00** Tiempo Final: **2022-05-31 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **20.0** min.
Región: **---** Nivel de vuelo: **10000 - 55000**
Cobertura RADAR: **---** ADS-B: **---** MLAT: **---**
M3/A: **0000 - 7777** Addr: **000000 - FFFFFF** ID:
DO260: **0 - 7** NICp: **6 - 11** NACp: **0 - 15** NACv: **0 - 7** SIL: **0 - 3 (Ave)**

Análisis por (NICp) Categoria de Integridad de la Navegación por posición.



Análisis de los datos según NICp

Parámetros	Cantidad	Porciento
NICp = 0 :	0	(0.0%)
NICp = 1 :	0	(0.0%)
NICp = 2 :	0	(0.0%)
NICp = 3 :	0	(0.0%)
NICp = 4 :	0	(0.0%)
NICp = 5 :	0	(0.0%)
NICp = 6 :	0	(0.0%)
NICp = 7 :	11	(0.7%)
NICp = 8 :	1503	(91.8%)
NICp = 9 :	114	(7.0%)
NICp = 10 :	9	(0.5%)
NICp = 11 :	0	(0.0%)
NICp = 12 :	0	(0.0%)
NICp = 13 :	0	(0.0%)
NICp = 14 :	0	(0.0%)
NICp = 15 :	0	(0.0%)
Filtro :	1637	

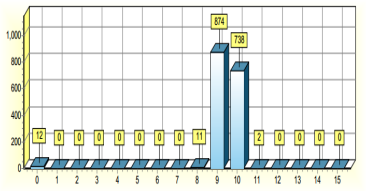
NIC

Reporte de Sistemas de Vigilancia

FIR México

Tiempo Inicio: **2022-05-01 00:00** Tiempo Final: **2022-05-31 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **20.0** min.
Región: **---** Nivel de vuelo: **10000 - 55000**
Cobertura RADAR: **---** ADS-B: **---** MLAT: **---**
M3/A: **0000 - 7777** Addr: **000000 - FFFFFF** ID:
DO260: **0 - 7** NICp: **6 - 11** NACp: **0 - 15** NACv: **0 - 7** SIL: **0 - 3 (Ave)**

Análisis por (NACp) Categoria de Precisión de la Navegación por posición.



Análisis de los datos según NACp

Parámetros	Cantidad	Porciento
NACp = 0 :	12	(0.7%)
NACp = 1 :	0	(0.0%)
NACp = 2 :	0	(0.0%)
NACp = 3 :	0	(0.0%)
NACp = 4 :	0	(0.0%)
NACp = 5 :	0	(0.0%)
NACp = 6 :	0	(0.0%)
NACp = 7 :	0	(0.0%)
NACp = 8 :	11	(0.7%)
NACp = 9 :	874	(53.3%)
NACp = 10 :	738	(45.0%)
NACp = 11 :	2	(0.1%)
NACp = 12 :	0	(0.0%)
NACp = 13 :	0	(0.0%)
NACp = 14 :	0	(0.0%)
NACp = 15 :	0	(0.0%)
Filtro :	1637	

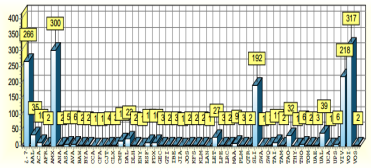
NACp

Reporte de Sistemas de Vigilancia

FIR México

Tiempo Inicio: **2022-05-01 00:00** Tiempo Final: **2022-05-31 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **20.0** min.
Región: **---** Nivel de vuelo: **10000 - 55000**
Cobertura RADAR: **---** ADS-B: **---** MLAT: **---**
M3/A: **0000 - 7777** Addr: **000000 - FFFFFF** ID:
DO260: **0 - 7** NICp: **6 - 11** NACp: **0 - 15** NACv: **0 - 7** SIL: **0 - 3 (Ave)**

Análisis por Aerolíneas.



Listado por Aerolíneas / Sistemas

No	Code	Airline Name	Count.	RADAR	ADSB	MLAT
1	¿.?	*¿.?*	266	0	266	0
2	AAL	*American Airlines*	35	0	35	0
3	ACA	*Air Canada*	10	0	10	0
4	AFR	*Air France*	2	0	2	0
5	AMX	*Aeromexico*	300	0	300	0
6	ANA	*ANA - All Nippon Airways*	2	0	2	0
7	ASA	*Alaska Airlines*	5	0	5	0
8	AVA	*Avianca*	6	0	6	0
9	BAW	*British Airways*	2	0	2	0
10	BYA	*Berry Aviation*	2	0	2	0
11	CCA	*Air China*	1	0	1	0
12	CFA	*China Flying Dragon Aviation*	1	0	1	0
13	CJT	*Cargojet Airways*	4	0	4	0
14	CLX	*Cargolux*	3	0	3	0
15	CMP	*Copa Airlines*	15	0	15	0
16	DAL	*Delta Air Lines*	22	0	22	0
17	DLH	*Lufthansa*	2	0	2	0
18	ENY	*Envoy Air*	1	0	1	0
19	ESF	*Estafeta Carga Aérea*	11	0	11	0
20	FDX	*FedEx Express*	10	0	10	0
21	GEC	*Lufthansa Cargo*	3	0	3	0
22	GTI	*Atlas Air*	2	0	2	0
23	IBE	*Iberia*	3	0	3	0

By Airline

Reporte de Sistemas de Vigilancia

FIR México

Tiempo Inicio: **2022-05-01 00:00** Tiempo Final: **2022-05-31 00:00**
Tiempo de vuelo: **00:10:00 - 23:59:59** Espera: **20.0** min.
Región: **---** Nivel de vuelo: **10000 - 55000**
Cobertura RADAR: **---** ADS-B: **---** MLAT: **---**
M3/A: **0000 - 7777** Addr: **000000 - FFFFFF** ID:
DO260: **0 - 7** NICp: **6 - 11** NACp: **0 - 15** NACv: **0 - 7** SIL: **0 - 3 (Ave)**

Análisis por Aerolíneas.

Listado de vuelos por Aerolíneas.
(¿.?)

No	Address	Register	Flight ID	Code	Cnt	260	NICp	NACp	NACv	SIL	SDA	GVA	Cumple
1	000680	¿.?	XAAFA	?E?	1	2	8	10	2	3	2	2	SI
2	000000	¿.?	XBPBT	?E?	1	2	9	10	2	3	2	2	SI
3	0B0CBD	¿.?	XBRFZ	?E?	1	2	9	10	2	3	2	2	SI
4	0C0920	¿.?	XALDB	?E?	1	2	8	10	2	3	2	2	SI
5	000115	XATIF	XATIF	?E?	1	2	9	10	2	3	2	2	SI
6	000157	¿.?	XAAVO	?E?	1	2	9	10	2	3	2	2	SI
7	000100	¿.?	XAAAO	?E?	3	2	9	10	2	3	2	2	SI
8	000270	¿.?	XBPGP	?E?	2	2	9	10	2	3	2	2	SI
9	000285	XAFAF	XAFAF	?EM	1	2	8	10	2	3	2	2	SI
10	000356	¿.?	XAALE	?E?	2	2	9	10	2	3	2	2	SI
11	000366	¿.?	XCBJG	?E?	1	2	10	10	1	3	2	2	SI
12	000BBF	XBRSC	XBRSC	?EM	2	2	8	9	2	3	2	2	SI
13	000BF0	¿.?	XAGIU	?E?	1	2	8	10	2	3	2	2	SI
14	000425	XAGMX	XAGMX	?EM	1	2	8	10	2	3	2	2	SI
15	000501	¿.?	XAORO	?E?	2	2	9	10	2	3	2	2	SI
16	0005SF	XAAVZ	XAAVZ	?EM	1	2	8	10	1	3	2	2	SI
17	0005F6	XAONE	XAONE127	?EM	2	2	8	10	1	3	2	2	SI
18	0005FD	XABUX	XABUX	?EM	1	2	9	10	2	2	2	2	SI
19	00060F	XAACR	ACW2400	?E?	1	2	8	10	1	3	2	2	SI
20	00065F	ANX12O3 | AN	N61WF	?E#	2	2	8	10	2	3	2	2	SI
21	00067F	XAEGL	1201	?E#	1	2	9	10	2	3	2	2	SI
22	00067F	XAEGL	ACW1200	?E?	1	2	9	10	2	3	2	2	SI
23	00D6A4	¿.?	XANDR	?E?	1	2	9	10	2	3	2	2	SI
24	00D6C6	XAXTR	XAGSL000	?E?	1	2	10	10	1	3	2	2	SI
25	00071A	XAATI	XAATI	?EM	1	2	8	10	2	3	2	2	SI
26	000731	¿.?		?EX	1	2	8	9	2	3	2	2	SI
27	00073D	XAGAT	XAGAT	?EM	1	2	8	10	1	3	2	2	SI
28	00075A	XAELX	XAELX	?EM	1	2	8	10	2	3	2	2	SI
29	00076A	XAANA	XAANA	?EM	1	2	8	10	1	3	2	2	SI
30	000796	XAUSZ	XAUSZ	?EM	1	2	8	10	1	3	2	2	SI
31	000TAA	XACAR | XAKU	ACW1602	?E?	2	2	8	10	2	3	2	2	SI
32	000TD1	XAMMA	XAMMA	?EM	1	2	8	10	2	3	2	2	SI
33	000TE2	¿.?	XALCD	?E?	1	2	8	10	1	3	2	2	SI

by Complying Criteria

Appendix B

Public ADS-B Performance Report (PAPR) User's Guide

Flight Standards Service

ADS-B Focus Team

Aircraft Maintenance Division

Avionics Branch

March 2020

Background – Public ADS-B Performance Report

The purpose of the Public ADS-B Performance Report (PAPR) is to provide aircraft owners, operators, and avionics installers/maintainers with an additional method of verifying proper operation of ADS-B Out equipment.

The purpose of this User's Guide is to provide information to aid in the interpretation of data associated with a PAPR and to provide general guidance to help resolve avionics issues identified within a PAPR.

PAPR data provides information on the performance of an aircraft's ADS-B system for a specific flight and will verify proper ADS-B system operation or identify specific parameters received by the FAA's ground system which failed to comply with established standards. ADS-B system performance data identified within a PAPR will be useful to aircraft avionics maintainers when performing post-installation compliance/configuration checks and fault isolation.

A PAPR is typically available 1 hour after the end of the flight at the following web address https://adsbperformance.faa.gov/PAPRRequest.aspx. However, the availability of a PAPR may be delayed due to system maintenance or outages. unexpected. In cases where a PAPR is not available at the web address, the user must send an email to the following address 9-AWA-AFS-300-ADSBAvionicsCheck@faa.gov, and include the following information:

1. Aircraft registration number (N number) in the subject line;

2. In the body of the email include

a. Flight identification code;

b. Date and time of the flight;

c. ADS-B transmitter and GPS make/model; Y

d. Any ADS-B avionics malfunction observed or reported during the associated flight.

Part 1 – Public ADS-B Performance Report Explanation

The FAA collects data in the following flight phases by ADS-B link type (See Figure 1):

1. 1090 – Airborne
2. 1090 - Surface 4(Outside RWY/Taxi area)
3. 1090 - Surface RWY/Taxi
4. UAT - Airborne
5. UAT - Surface (Outside RWY/Taxi area)
6. UAT - Surface RWY/Taxi

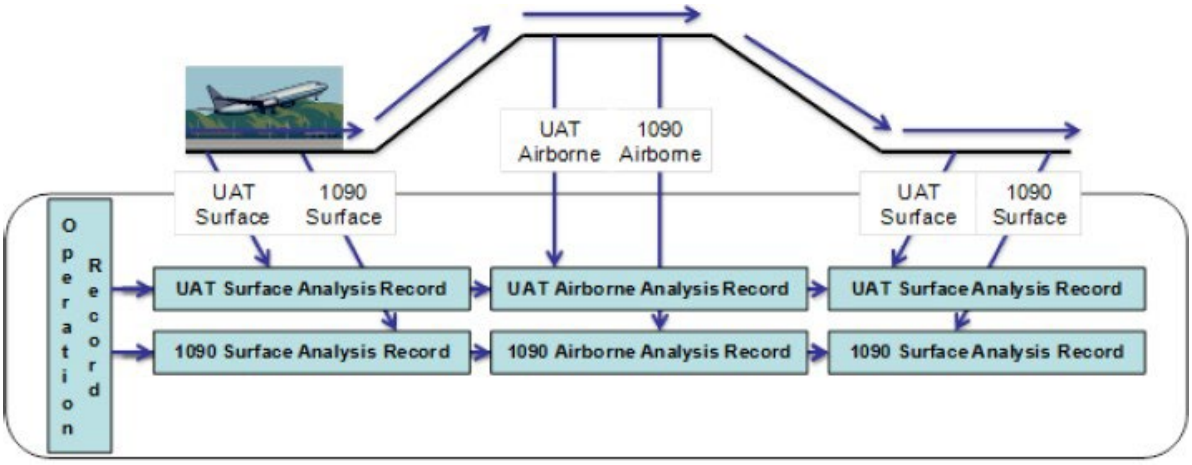


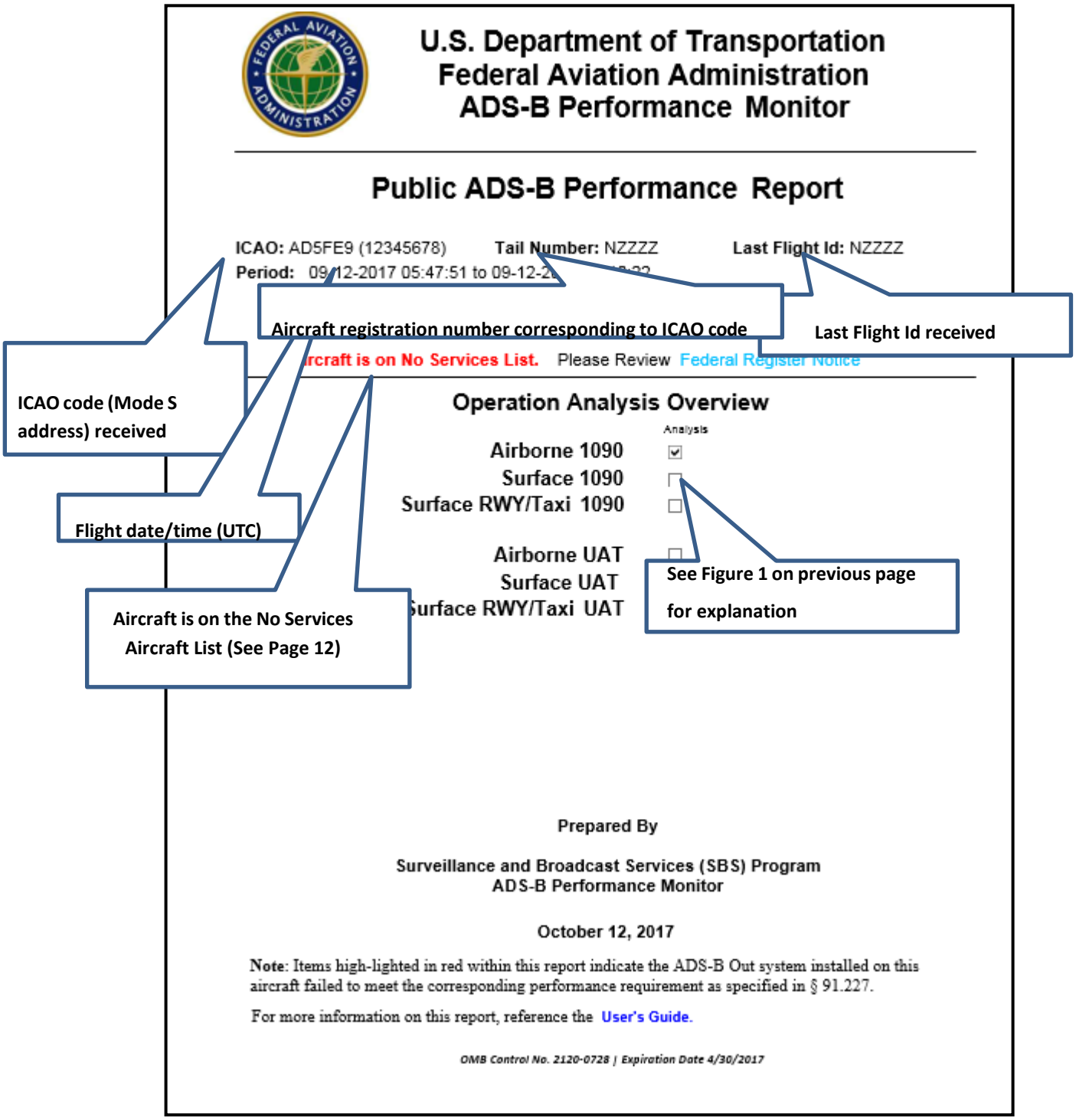
Illustration of how data is collected in operation and analysis records

Figure 1

[4] Surface information is only provided at U.S. locations where a surface service volume exists. As of this writing, this is limited to the 35 airports with an ASDE-X system and KSFO. Eight additional surface service volumes will be added as the Airport Surface Surveillance Capability (ASSC) is deployed.

PAPR Cover Page

The cover page contains basic information about the aircraft, flight date/time, and the type of ADS-B information received (1090, UAT, airborne/surface). Verify this information is correct.



Each PAPR begins with an Operation Summary with specific information about the aircraft and flight. An example of an Operation Summary Table and definitions are provided below.

Operation Summary Table Example

Operation Summary

Operation Id:	55555555	**Start Time:** 09-12-2017 05:47:51		
ICAO Reported:	AAABBB (12345678)	**End Time:** 09-12-2017 07:10:22		
ICAO Assigned:	AAABBB (12345678)	**Duration:** 01:22:31	**Mod:** 01:22:31	**Rule:** 01:14:51
Tail Number:	NZZZZ	**Reports:** 10419	**Best Msg:** 9033	**TIS-B Client %:** 0.0%
Country:	United States - Civil	**Stationary:** No	**Baro Alt (ft):** 36975	- 37000

Detection: ☑ **Airborne** ☐ **Surface**

Link Version:	2	**Out Capability:**	1090	**In Capability:**	
Last Flight Id:	NZZZZ				
Operator:	ABC				

Operation Summary Explanation Table

Operation Id: Unique number assigned to the flight record.		**Start Time:** Time flight was first monitored.
ICAO Reported & ICAO Assigned: The 24- bit ICAO address (hexadecimal & octal formats) received from the aircraft.		**End time:** Time flight was last monitored.
Tail Number: The N-number associated with the aircraft's reported 24-bit ICAO code.	**Duration:** Duration of the monitored flight in hours, minutes, and seconds.	**Mod:** Flight duration minus any data gaps greater than 36 seconds.
Country: Country associated with aircraft registration (identified via received ICAO hexadecimal code).	**Reports:** Number of ADS-B downlinks received during this operation.	**BestMSG**: Total reports minus any duplicate reports.
Detection: Flight mode(s) where aircraft was monitored (airborne and/or surface).	**Stationary Only: "**No" indicates aircraft was not stationary. "Yes" indicates aircraft was stationary for duration of this Operation.	**TIS-B Client %:** Percentage of operation time TIS-B data was provided to the aircraft by the ADS-B ground system.
Link Version: Link version of ADS-B transmitter. Link Version 2 is required by 14 CFR 91.225 and 14 CFR 91.227.	**Baro Alt (ft):** The minimum and maximum Barometric Pressure altitude reported by the aircraft.	**Rule:** Time spent within ADS-B Out Rule Airspace. Rule Airspace is defined in 14 CFR Part 91.225.
Last Flight Id: Last flight identification code received. This should be identical to the aircraft call sign used by ATC.	**Out Capability** Frequency used to transmit ADS-B data (i.e. 1090, 978/UAT, or Dual) or ADS-B OUT system type (UAT or 1090)	
Operator: Unique air operator identification code.		**In Capability:** Indication of capability to receive ADS- B data on specified link

Dual-Out Inconsistencies

If an aircraft is equipped with a 1090 and a UAT system and transmitting on both frequencies (referred to as Dual-Out), the following table will be provided to identify any differences in the data received from each system. In the table below, the FAA ground system is receiving length/width codes from the 1090 and UAT avionics that do not match (LWC field is highlighted in red) for a Dual-Out equipped aircraft. See Part 3 of this report for table header definitions.

Dual Out Inconsistencies:

Category	Emit Cat	Flight ID	Mode 3A	SAF	LWC	GPS Pos
% Fail	0.00%	0.00%	0.03%	0.00%	100.00%	100.00%
Max dT	00:00:00	00:00:00	00:00:04	00:00:00	00:02:56	00:02:56
MCF	0	0	4	0	338	338

Performance Analysis Summary Tables

Analysis Summary tables are presented in the PAPR for some, or all, of the following categories depending on the installed ADS-B avionics configuration (1090 only, UAT only, or Dual-Out), areas of operation, and availability of ADS-B coverage:

- Airborne - 1090
- Surface - 1090 (Outside RWY/Taxi area)
- Surface RWY/Taxi - 1090
- Airborne - UAT
- Surface - UAT (Outside RWY/Taxi area)
- Surface RWY/Taxi UAT

The following definitions apply to all tables in each performance assessment category:

Category	Definitions
% Fail	**Percentage of flight that corresponding category element failed performance assessment.**
Max dT	**Total time during flight the message element failed performance assessment.**
MCF	**Maximum number of consecutive received ADS-B messages in which the element failed Performance assessment.**

Note: An example of a Performance Analysis Summary table and summary term definitions are provided on the next page.

Analysis Summary Example (Airborne 1090)

Airborne 1090 Analysis Summary

Start Time: 11-26-2015 20:25:18 **End Time:** 11-26-2015 22:06:55

Duration(s): 01:41:37 **Mod:** 01:24:47 **Processed Reports:** 13444 **Total Reports:** 13491

Link Version: 2 **Out Capability:** 1090 **In Capability:** UAT

Emitter Category: 1 - Light (<15,500lbs) **Antenna(s):** 1 - Single

Last Flight Id: NZZZZ

Last Mode 3A: 4511

Exceptions:

NIC	NACp	NACv	SIL	SDA
Yes	Yes	Yes	Yes	No

Analysis Summary Explanation

Start Time: The start time of the flight as observed by ground monitoring.			**End Time:** The end time of the flight as observed by ground monitoring.
Duration(s): Duration of flight in hours, minutes, and seconds.	**Mod**: Duration minus any data gaps greater than 36 seconds.	**Processed Reports:** Number of reports processed by the ADS-B Ground system.	**Total Reports:** Total reports including duplicates.
Link Version: Indicates which 1090/UAT standard the ADS-B equipment complies with. (For 1090 DO-260 = 0, DO-260A = 1, DO-260B = 2, etc.)	**Out Capability:** ADS-B OUT system type (UAT or 1090).		**In Capability:** ADS-B IN system type (UAT or 1090).
Emitter Category: Code associated With the aircraft's size, weight, or performance characteristics.	**Antenna(s):** Single or Dual (top and bottom) ADS-B antenna installed.		
Last Flight Id: The last reported Flight ID received from the aircraft.			
Last Mode 3A: Last discrete Mode 3/A code received.			
Exceptions: **NIC/NAC/NACp/SIL/SDA Value:** Indicates if aircraft failed to meet performance requirements of identified parameter: **Yes = Fail** **No = Pass**			

Performance Assessment Tables

ADS-B equipment performance is divided into the following 4 major assessment categories:

1. **Required Message Elements Checks (Missing Elements):** Check of 14 CFR §91.227 (d) specified message elements required for broadcast by ADS-B Out avionics.
2. **Integrity and Accuracy Checks:** Check of ADS-B Out NIC/NACp/NACv/SDA/SIL performance requirements specified by 14 CFR §91.227(c) (Ref. latest version of Advisory Circular (AC) 20-165 for additional information).
3. **Kinematics:** Includes reasonableness checks of changes in Baro/Geo altitude, horizontal position, and velocity.
4. **Other Checks:** Checks of specific message parameters for values outside an expected range or fields that are improperly formatted (24-bit ICAO address, Mode 3A, emitter category, etc.).

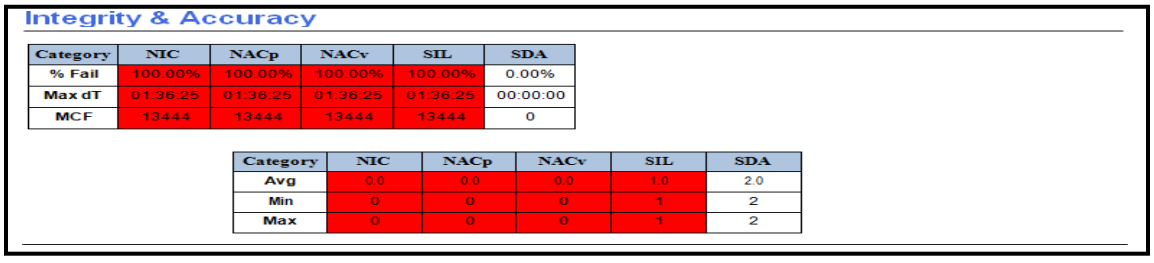
See Part 3 of this report for table header definitions.

1. **Missing Elements:** Missing elements will be highlighted in red by category if aircraft failed to meet performance requirements.

Missing Elements[5]

Category	NACp	NACv	Vel[2]	Flight Id	Mode 3A	Emit Cat
% Fail	0.00%	0.00%	27.15%	0.00%	0.00%	0.00%
Max dT	00:00:00	00:00:00	00:01:13	00:00:00	00:00:00	00:00:00
MCF	0	0	68	0	0	0

2. **Integrity & Accuracy:** Failed Integrity & Accuracy categories will be highlighted in red if aircraft failed to meet performance requirements. The FAA has not approved, or otherwise evaluated, any ADS- B position source with the horizontal velocity accuracy performance required to transmit a NACv value greater than 2 (NACv of 2 = Estimated Velocity Uncertainty <3 m/s). When NACv MIN and/or AVG are highlighted yellow in the Integrity & Accuracy table of the report (i.e. transmitted NACv MIN/AVG is 3 or 4) you are advised to contact your installer and/or applicable ADS-B avionics manufacturer for guidance on how to change the NACv value to that approved by the FAA at certification, or for non- certified equipment, a NACv value not to exceed 2 without FAA evaluation.



Integrity & Accuracy

Category	NIC	NACp	NACv	SIL	SDA
% Fail	100.00%	100.00%	100.00%	100.00%	0.00%
Max dT	01:36:25	01:36:25	01:36:25	01:36:25	00:00:00
MCF	13444	13444	13444	13444	0

Category	NIC	NACp	NACv	SIL	SDA
Avg	0.0	0.0	0.0	1.0	2.0
Min	0	0	0	1	2
Max	0	0	0	1	2

Integrity & Accuracy Note: If using an uncertified GPS (or portable transmitter) the system must report as SIL = 0 (zero). SIL=0 transmitters do not meet the requirements to become a TIS-B Service Client.

[5] Note: The ADS-B Performance Monitor (APM) expects track angle data to be present in Velocity (Vel) messages when aircraft are moving on the surface above 10kts. Some avionics manufacturers have determined their system's track angle is unreliable at ground speeds above 10kts and withhold the data from the Vel message based on this determination. When this occurs an associated PAPR will indicate failures for Missing Element Vel within the Surface UAT/1090 Analysis section. Users are advised to contact their ADS-B equipment installer/avionics manufacturer for guidance when a PAPR indicates a failure for Missing Element Vel on the surface to determine if corrective action is required.

3. **Kinematics:** A reasonableness check is made of changes in Baro/Geo Altitude, Position, and Velocity. Items highlighted in red were identified with position changes outside the range expected for normal aircraft performance.

Kinematics

	Velocity	Position Δ
% Fail	0.00%	0.00%
MCF	0	0

Baro Alt	Baro Alt Δ	Geo Alt	Geo Alt Δ
0.00%	0.00%	0.00%	0.00%
0	0	0	0

4. **Other Checks:** A percentage of the total operation (% Fail) and the maximum consecutive failures (MCF) that the ADS-B avionics failed to correctly broadcast these message elements.

Other Checks

	Emitter Cat	Mode 3A
% Fail	0.00%	0.00%
Max dT	00:00:00	00:00:00
MCF	0	0

	Flight ID	Tail # Mismatch	Non-US	No "N"	Only "N"	Partial	Spaces	All Spaces	Illegal Char	Unavail Char	FP ID Mismatch
% Fail	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.13%	0.00%	0.00%
Max dT	00:00:02	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:02	00:00:00	00:00:02	00:00:00	
MCF	2	0	0	0	0	0	2	0	2	0	

	Air on Ground
% Fail	0.00%
Max dT	00:00:00
MCF	0

Other Checks table header definitions (See Part 3 of this guide):

Emitter Category: Percent, total time, and max consecutive reports aircraft reported an Emitter Category = 0.

Mode 3A: Percent, total time, and max consecutive reports aircraft was flagged as having an invalid Mode 3/A. In the majority of cases, this indicates if the aircraft did not report Mode 3/A via ADS-B for some or all of the flight.

Flight ID: The received Flight ID code is assessed in the following ways:

1. **Flight ID** = Percent, total time, and max consecutive reports aircraft reported an incorrect Flight ID (any flight ID error)
2. **Tail # Mismatch** = Percent, total time, and max consecutive reports aircraft reported a N-Number Flight ID that doesn't match the N-Number derived from the 24-bit ICAO (U.S. aircraft only) code.
3. **No-US** = Percent, total time, and max consecutive reports aircraft reported an N-Number Flight ID with an 24-bit ICAO address outside the U.S. block.
4. **No "N"** = Percent, total time, and max consecutive reports aircraft reported an N Number Flight ID without

the leading “N” (e.g., 123AB vs N123AB).

5. **Only “N”** = Percent, total time, and max consecutive reports aircraft reported just “N” for flight ID.
6. **Partial** = Mostly for Air Carriers, percent, total time, and max consecutive reports aircraft reported a Flight ID missing the leading three letter identifier (e.g. 1234 vs JBU1234).
7. **Spaces** = Percent, total time, and max consecutive reports aircraft including a space within a Flight ID.
8. **All Spaces** = Percent, total time, and max consecutive reports aircraft reported a Flight ID with eight spaces.
9. **Illegal Character** = Percent, total time, and max consecutive reports aircraft reported a Flight ID with an Illegal Character.
10. **Unavail Character** = Percent, total time, and max consecutive reports aircraft reported a Flight ID with an Unavailable Character.
11. **FP ID Mismatch** = Percent of total flight the aircraft's transmitted Flight ID did not match the aircraft identification information filed on the applicable flight plan.

Note: The FP ID Mismatch field can be disregarded when no flight plan was filed for the flight associated with the PAPR.

12. **Air on Ground** = Percent, total time, and max consecutive reports the FAA ground system received airborne formatted messages while the aircraft was on the ground.

Part 2 – Guidance for PAPR Faults

This section provides general guidance on common ADS-B performance issues and their possible causes. The information in this section is based on observations and feedback from avionics manufacturers, repair stations, and individual aircraft owner/operators. While the information is not specific to any make/model of ADS-B transmitter or GPS, users may find it helpful in determining a course of action to resolve issues identified within a PAPR.

PAPR Fault Table

PAPR Fault (Red Field)	Possible Causes
Missing Elements and Integrity & Accuracy Category Problems	
NIC, NACv, NACp, SIL and/or SDA (100% fail)	• Component and/or software compatibility with position source • Improper system configuration
NIC, NACv, NACp, SIL and/or SDA (partial failure)	• Intermittent loss of GPS service • Antenna masking caused by maneuvering • Portion(s) of flight at fringe of ADS-B coverage • Component software issue
Flight ID (100% fail)	• Flight ID not configured in avionics or Flight ID transmit is inhibited
Flight ID missing (partial fail)	• Flight at fringe of ADS-B coverage
Mode 3/A (100% fail)	• Because the FAA ground system auto-populates ADS-B messages with 1200 when the Mode 3/A code is missing to prevent risk associated with potential ATC conflict alerts this field should always show as passed. Refer to "Other Checks" below for guidance on Mode 3/A issues.
Mode 3/A (partial failure)	• See "Other Checks" below
Baro Alt	• Loss of data from barometric pressure altitude source (encoder)
Geo Alt	• Loss of geometric altitude data from GPS
Emitter Category (Missing and Other)	• Emitter category not configured into avionics or misconfigured
Flight Identification Code errors	• Flight ID not properly entered
Kinematics	
All parameters	• Component and/or software (version) compatibility
Other Checks	

Air on Ground (ADS-B system transmitting in Air mode while on the ground)	• Squat switch issue
	• GPS stall speed setting incorrect
	  ○ Too low a stall speed will result in avionics transitioning to Air mode during high speed taxi or takeoff-roll
	  ○ Avionics initializing in Air mode at startup

PAPR Fault Table (continued)	
PAPR Fault (red)	**Possible Causes**
Other Checks (continued)	
Emitter Cat	• Inappropriate emitter category transmitted. e.g., many "Light" aircraft (<15,500 lbs) incorrectly transmit as "Small" aircraft (15,500 – 75K lbs). • Rotorcraft transmitting fixed-wing emitter category
Mode 3A (100% fail)	• Mode 3/A or Call-sign logic transmit function disabled (UAT specific) • Mode 3/A code input device not providing data to UAT system
Mode 3A (partial failure)	• Portion(s) of flight at fringes of ADS-B coverage • Improper pilot input (late turn on/early turn off of transponder)
No flight data found for specified date	• Aircraft transmitting wrong 24-bit ICAO address • Late day flight (flight times are recorded in UTC) • Flight with UAT system operated in anonymous mode. • Possible ADS-B service outage • Aircraft not transmitting ADS-B data

ADS-B No Services Aircraft List (NSAL) Information

Background: Reference FAA Notice Docket Number: FAA-2017-1194. To reduce the potential hazard presented by ADS-B non-performing equipment (NPE) aircraft, the FAA began filtering individual 24-bit ICAO address codes (also known as Mode S codes) for certain NPE aircraft from the FAA's operational ADS-B network on January 2, 2018. The filtering process is managed through an exclusion list referred to as the No Services Aircraft List (NSAL) which prevents processing of data within ATC systems transmitted by aircraft contained on the list. Aircraft on the NSAL cannot be provided ATC services (via ADS-B data) and are excluded from the provision of TIS-B services. If authorized by ATC, traffic services for aircraft on the NSAL may be supported via the backup transponder/radar surveillance system. The NSAL has no impact on an ADS- B equipped aircraft's air-to-air capabilities.

Aircraft on the NSAL are identified by "Aircraft is on No Services List" on the cover page of an applicable PAPR. Since aircraft on the NSAL cannot be detected by ATC via their transmitted ADS-B data, each operation conducted in §91.225 airspace by applicable aircraft on the NSAL must be authorized by ATC before flight using the ADS-B Deviation Authorization Preflight Tool (ADAPT).

Procedures for removal of aircraft from the NSAL: The FAA provides written notice of NPE aircraft (with applicable NSAL information) to the person/entity and address associated with the aircraft's registration.

Owner/operators receiving an NPE notification should contact the FAA representative identified on the letter as soon as possible. When a PAPR indicates an aircraft is on the NSAL but a NPE notification letter has not been received by the owner/operator, contact the FAA at the following email address: 9-AWA-AFS-300-ADSB-AvionicsCheck@faa.gov providing the PAPR associated with the aircraft's most recent flight. An FAA

representative will contact you as soon as possible to discuss details associated with the performance of subject ADS-B equipment.

Part 3

ADS-B TERMS, DESCRIPTIONS AND REFERENCES

Parameter Description

Field Name	Full name	Description
Airborne Msgs on Surface		Indication that airborne specific messages were received by the FAA ground system while aircraft was on the surface
All Spaces	Flight ID	Flight identification code contains all spaces
Anonymous		Indicates whether the unit is in Anonymous mode or not.
Baro Alt/ Baro Alt Δ	Barometric Altitude	Barometric altitude is sent and checked against aircraft performance criteria and flagged as invalid if determined to be incorrect or unreasonable. In general, if the reported baro or geo alt is greater than 20,000 meters (65,616ft) or less than -200 meters (-656ft), the report is flagged for investigation. If there's a change in baro alt greater than 656 feet/sec (200m/s), then the report is flagged for investigation.
Class A		Field marks classes of airspace the aircraft operated in during the flight. Part 91 Appendix D is a special class of airspace for certain airports.
Class B		
Class C		
Class D		
Class E		
Part 91AppD		
Country		Field Identifies the country of origin for the aircraft and the type of registration (e.g. United States- Civil, Military, etc.)
Dup ICAO	Duplicate ICAO	Each aircraft is assigned a unique 24-bit ICAO address. When two or more aircraft are monitored operating simultaneously with the same 24-bit ICAO address both aircraft (correct & incorrect 24-bit ICAO) will be flagged for Dup ICAO.
Dup ICAO Duration	Duration Dup ICAO operation occurred	This field marks the duration that a duplicate 24-bit ICAO address is observed.
Duration		Total flight time measured in hours, minutes, and seconds.

Emitter Category		Indication of aircraft characteristics (type/size/weight/performance. Used by future ADS-B IN applications e.g., wake avoidance. Set A 0 = No ADS-B Emitter Category Information 1 = Light (< 15500 lbs) 2 = Small (15500 to 75000 lbs) 3 = Large (75000 to 300000 lbs) 4 = High Vortex Large (aircraft such as B-757) 5 = Heavy (> 300000 lbs) 6 = High Performance (> 5g acceleration and 400 kts) 7 = Rotorcraft
Flight ID	Flight Identification Code	This should match the aircraft call sign used in ATC communication. Must match the aircraft call sign in any filed flight plan.
Geo Alt/Geo Alt Δ	Geometric Altitude	Received geometric altitude is checked against aircraft performance criteria and flagged as invalid if determined to be incorrect or unreasonable. In general, if the reported baro or geo alt is greater than 20,000 meters (65,616ft) or less than -200 meters (-656ft), the report is flagged. If there's a change in geo alt greater than 656 feet/sec (200m/s), this field will also be flagged.
ICAO Assigned		Unique six character ICAO address assigned to an aircraft at registration. ICAO code is the same as the Mode S address.
ICAO Reported		Unique six character ICAO address transmitted by the aircraft.
Illegal Char	Flight ID illegal character	Flight ID contains an incorrect character (e.g., letter O in place of the number zero, etc.)
In capability		Indicates the link type transmitted for the ADS-B IN capability (1090/UAT).
Int/Acc	Integrity and Accuracy	Category of values including NIC, NACp, and NACv.
Kin	Kinematics	Category of exceptions that includes Baro Alt, Baro Alt Δ, Geo Alt, Geo Alt Δ, Velocity, Position Δ. Position error checks.
Length/Width Code		Code received that indicates the length and width of the aircraft.
Link Version		Field marking what version of ADS-B the transponder is using. §91.225 and §91.227 require Link Version 2.
MCF	Maximum Consecutive Failures	The number of non-performing reports received that occur in a row (consecutively). If an MCF exceeds its threshold, an MCF exception is identified for that parameter.
Mismatch		Percent, total time, and max consecutive reports aircraft reported a N-Number Flight ID that doesn't match the N-Number derived from the 24-bit ICAO address.
Missing report duration		Time period of flight segment that ADS-B data was not received from the aircraft. This can be caused by failure of the avionics or transiting in and out of ADS-B coverage.
Mode 3/A		Four digit code (ATC assigned or 1200) set by the pilot

<table>
<tr>
<td>NACp</td>
<td>Navigation Accuracy Category for Position</td>
<td>This field indicates the accuracy of the aircraft position being transmitted. §91.227 requires a minimum NACp of 8. A PAPR will be flagged red if the NACp of <8 duration exceeds the allowable threshold.

<u>Table A-13:</u> Encoding of Navigation Accuracy Category for Position (NAC_P)
<table><tr><th colspan="2">Coding</th><th rowspan="2">Meaning = 95% Horizontal Accuracy Bounds (EPU)</th></tr><tr><th>(Binary)</th><th>(Decimal)</th></tr><tr><td>0000</td><td>0</td><td>EPU ≥ 18.52 km (10 NM) - Unknown accuracy</td></tr><tr><td>0001</td><td>1</td><td>EPU < 18.52 km (10 NM) - RNP-10 accuracy</td></tr><tr><td>0010</td><td>2</td><td>EPU < 7.408 km (4 NM) - RNP-4 accuracy</td></tr><tr><td>0011</td><td>3</td><td>EPU < 3.704 km (2 NM) - RNP-2 accuracy</td></tr><tr><td>0100</td><td>4</td><td>EPU < 1852 m (1NM) - RNP-1 accuracy</td></tr><tr><td>0101</td><td>5</td><td>EPU < 926 m (0.5 NM) - RNP-0.5 accuracy</td></tr><tr><td>0110</td><td>6</td><td>EPU < 555.6 m (0.3 NM) - RNP-0.3 accuracy</td></tr><tr><td>0111</td><td>7</td><td>EPU < 185.2 m (0.1 NM) - RNP-0.1 accuracy</td></tr><tr><td>1000</td><td>8</td><td>EPU < 92.6 m (0.05 NM) - e.g., GPS (with SA)</td></tr><tr><td>1001</td><td>9</td><td>EPU < 30 m - e.g., GPS (SA off)</td></tr><tr><td>1010</td><td>10</td><td>EPU < 10 m - e.g., WAAS</td></tr><tr><td>1011</td><td>11</td><td>EPU < 3 m - e.g., LAAS</td></tr><tr><td>1100 - 1111</td><td>12 - 15</td><td>Reserved</td></tr></table>
NACp values < 8 will be flagged red.</td>
</tr>
<tr>
<td>NACv</td>
<td>Navigation Accuracy Category for velocity</td>
<td><table><tr><th colspan="3">Navigation Accuracy Category for Velocity</th></tr><tr><th colspan="2">Coding</th><th rowspan="2">Horizontal Velocity Error</th></tr><tr><th>(Binary)</th><th>(Decimal)</th></tr><tr><td>000</td><td>0</td><td>≥ 10 m/s</td></tr><tr><td>001</td><td>1</td><td>< 10 m/s</td></tr><tr><td>010</td><td>2</td><td>< 3 m/s</td></tr><tr><td>011</td><td>3</td><td>< 1 m/s</td></tr><tr><td>100</td><td>4</td><td>< 0.3 m/s</td></tr></table>
Navigation Accuracy Category for Velocity (NACv). NACv is based on design data provided by the position source manufacturer. The NACv may be updated dynamically from the position source, or set statically based on qualification of the position source.

(a) A NACv = 1 (< 10 m/s) may be permanently set at installation for GNSS equipment passing the tests identified in appendix 2, or may be set dynamically from velocity accuracy output of a position source qualified in accordance with the AC 20-165B appendix B guidance.
(b) A NACv = 2 (< 3 m/s) may be set dynamically from velocity accuracy output of a position source qualified in accordance with the</td>
</tr>
</table>

<table>
<tr><td></td><td></td><td>Appendix 2 guidance. NACv = 2 should not be permanently preset at installation, even if the position source has passed the tests identified in AC 20-165B appendix B.
A NACv = 3 or NACV = 4 should not be set based on GNSS velocity accuracy unless you can demonstrate to the FAA that the velocity accuracy
actually meets the requirement.</td></tr>
<tr><td>NIC</td><td>Navigation Integrity Category</td><td>NIC encoding is used to indicate the radius of containment around the aircraft. §91.227 requires a minimum NIC of 7. NIC values of <7 will be flagged red within a PAPR when the MCF threshold is exceeded.
<table>
<tr><th rowspan="2">NIC Value</th><th rowspan="2">Radius of Containment (R_C)</th><th colspan="3">Airborne</th><th colspan="3">Surface</th></tr>
<tr><th>Airborne Position TYPE Code</th><th>NIC Supplement Codes A</th><th>B</th><th>Surface Position TYPE Code</th><th>NIC Supplement Codes A</th><th>C</th></tr>
<tr><td>0</td><td>R_C unknown</td><td>0, 18 or 22</td><td>0</td><td>0</td><td>0, 8</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>R_C < 20 NM (37.04 km)</td><td>17</td><td>0</td><td>0</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>2</td><td>R_C < 8 NM (14.816 km)</td><td>16</td><td>0</td><td>0</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>3</td><td>R_C < 4 NM (7.408 km)</td><td>16</td><td>1</td><td>1</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>4</td><td>R_C < 2 NM (3.704 km)</td><td>15</td><td>0</td><td>0</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>5</td><td>R_C < 1 NM (1852 m)</td><td>14</td><td>0</td><td>0</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="3">6</td><td>R_C < 0.6 NM (1111.2 m)</td><td>13</td><td>1</td><td>1</td><td>8</td><td>0</td><td>1</td></tr>
<tr><td>R_C < 0.5 NM (926 m)</td><td>13</td><td>0</td><td>0</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>R_C < 0.3 NM (555.6 m)</td><td>13</td><td>0</td><td>1</td><td>8</td><td>1</td><td>0</td></tr>
<tr><td>7</td><td>R_C < 0.2 NM (370.4 m)</td><td>12</td><td>0</td><td>0</td><td>8</td><td>1</td><td>1</td></tr>
<tr><td>8</td><td>R_C < 0.1 NM (185.2 m)</td><td>11</td><td>0</td><td>0</td><td>7</td><td>0</td><td>0</td></tr>
<tr><td>9</td><td>R_C < 75m</td><td>11</td><td>1</td><td>1</td><td>7</td><td>1</td><td>0</td></tr>
<tr><td>10</td><td>R_C < 25m</td><td>10 or 21</td><td>0</td><td>0</td><td>6</td><td>0</td><td>0</td></tr>
<tr><td>11</td><td>R_C < 7.5m</td><td>9 or 20</td><td>0</td><td>0</td><td>5</td><td>0</td><td>0</td></tr>
<tr><td>12</td><td colspan="6">Reserved</td></tr>
<tr><td>13</td><td colspan="6">Reserved</td></tr>
<tr><td>14</td><td colspan="6">Reserved</td></tr>
<tr><td>15</td><td colspan="6">Reserved</td></tr>
</table></td></tr>
<tr><td>NIC Baro</td><td></td><td>NIC baro is a one-bit field that is used to report if the altitude is being checked against another source of pressure altitude.
<table>
<tr><th>Coding</th><th>Meaning</th></tr>
<tr><td>0</td><td>The barometric altitude that is being reported in the Airborne Position Message is based on a Gilham coded input that has not been cross-checked against another source of pressure altitude</td></tr>
<tr><td>1</td><td>The barometric altitude that is being reported in the Airborne Position Message is either based on a Gilham code input that has been cross-checked against another source of pressure altitude and verified as being consistent, or is based on a non-Gilham coded source</td></tr>
</table></td></tr>
<tr><td>No “N”</td><td></td><td>Percent, total time, and max consecutive reports aircraft reported a N Number Flight ID without the leading “N”</td></tr>
<tr><td>Non-US</td><td></td><td>Percent, total time, and max consecutive reports aircraft reported a N Number
Flight ID and a 24-bit ICAO address outside the U.S. block</td></tr>
<tr><td>Operation Id</td><td></td><td>Unique flight identification number that is shown in the report to allow users to return to that operation to look at it again.</td></tr>
<tr><td>Other Checks</td><td></td><td>Category of checks that looks at assorted issues such as illegal characters in your flight ID, improper/missing Mode 3/A code, and Duplicate 24-bit ICAO
addresses. See Other Checks section in Part 1 of this document.</td></tr>
<tr><td>Only “N”</td><td></td><td>Percent, total time, and max consecutive reports aircraft reported just “N” for flight ID</td></tr>
<tr><td>Out Capability</td><td></td><td>Indicates the type of ADS-B Out link the transmitter operates on i.e., 1090,
UAT, Dual (both links)</td></tr>
</table>

<table>
<tr><td>Partial</td><td></td><td>Mostly for Air Carriers, percent, total time, and max consecutive reports aircraft reported a Flight ID missing the leading three letter identifier</td></tr>
<tr><td>Processed reports</td><td></td><td>Number of ADS-B reports actually processed by the FAA ground system</td></tr>
<tr><td>Rule</td><td></td><td>This overall category fails if you fail any of the categories mandated. If this box is labeled no, the test was a success.</td></tr>
<tr><td>SDA</td><td>System Design Assurance</td><td>Measures the likelihood of bad data being sent. Pass for values 2 and 3
<table>
<tr><th colspan="2">SDA Value</th><th>Supported Failure Condition Note 2</th><th>Probability of Undetected Fault causing transmission of False or Misleading Information Note 3,4</th><th>Software & Hardware Design Assurance Level Note 1,3</th></tr>
<tr><th>(decimal)</th><th>(binary)</th><th></th><th></th><th></th></tr>
<tr><td>0</td><td>00</td><td>Unknown/ No safety effect</td><td>$> 1x10^{-3}$ per flight hour or Unknown</td><td>N/A</td></tr>
<tr><td>1</td><td>01</td><td>Minor</td><td>$\leq 1x10^{-3}$ per flight hour</td><td>D</td></tr>
<tr><td>2</td><td>10</td><td>Major</td><td>$\leq 1x10^{-5}$ per flight hour</td><td>C</td></tr>
<tr><td>3</td><td>11</td><td>Hazardous</td><td>$\leq 1x10^{-7}$ per flight hour</td><td>B</td></tr>
</table></td></tr>
<tr><td>SIL</td><td>Source Integrity Level</td><td>Measurement of the probability of not being within the containment radius. Pass for value 3 only
<table>
<tr><th colspan="2">SIL Coding</th><th>Probability of Exceeding the NIC Containment Radius (R_C)</th></tr>
<tr><th>(Binary)</th><th>(Decimal)</th><th></th></tr>
<tr><td>00</td><td>0</td><td>Unknown or $> 1 \times 10^{-3}$ per flight hour or per sample</td></tr>
<tr><td>01</td><td>1</td><td>$\leq 1 \times 10^{-3}$ per flight hour or per sample</td></tr>
<tr><td>10</td><td>2</td><td>$\leq 1 \times 10^{-5}$ per flight hour or per sample</td></tr>
<tr><td>11</td><td>3</td><td>$\leq 1 \times 10^{-7}$ per flight hour or per sample</td></tr>
</table></td></tr>
<tr><td>SILs</td><td>Source Integrity Level Supplement</td><td>This is a one bit field that informs the system if the SIL is being given on a per hour or a per sample basis, assigned as 0 or 1 respectively</td></tr>
<tr><td>SQL</td><td>Signal Quality Level</td><td>Measure of integrity of data sent. Not used to determine if an operation makes it onto the exception list</td></tr>
<tr><td>Stationary only</td><td></td><td>Field that marks if the recorded flight was stationary (ground only)</td></tr>
<tr><td>Tail Number</td><td></td><td>Number assigned to the aircraft at registration (N-number)</td></tr>
<tr><td>TIS-B Client %</td><td></td><td>% of flight time that the aircraft was provided TIS-B data.</td></tr>
<tr><td>Total reports</td><td></td><td>Total reports broadcast by the ADS-B transmitter</td></tr>
<tr><td>Type Registration</td><td></td><td>Type of registration associated with aircraft e.g. civil, military, etc.</td></tr>
<tr><td>UAT Only above 18k</td><td></td><td>When flagged, indicates UAT-Only equipped aircraft operating in Class A airspace (above 18K feet) where 1090 ADS-B equipment is required by 91.225.</td></tr>
<tr><td>Unavail Char</td><td></td><td>Percent, total time, and max consecutive reports aircraft reported a Flight ID with an Unavailable Character</td></tr>
<tr><td>Vel/ Position Δ</td><td>Velocity & Position delta</td><td>Velocity is encoded in ADS-B messages. The performance monitor checks these values against aircraft performance and flags a PAPR if the velocity is greater than 300 meters/sec (583 knots or a position is greater than 1,312 feet/sec (400m/s).</td></tr>
</table>

Vertical Velocity		Vertical Velocity is encoded in ADS-B messages. The performance monitor checks these values against aircraft performance and flags any unusual or unreasonable values

Additional information about ADS-B can be found in the following documents:

1. Advisory Circular (AC) 90-114(current version), Automatic Dependent Surveillance-Broadcast (ADS-B) Operations
2. AC 20-165(current version), Airworthiness Approval of Automatic Dependent Surveillance – Broadcast (ADS-B) OUT Systems in Aircraft (guidance on ADS-B system design, certification, and installation).
3. Aeronautical Information Manual
4. 14 CFR §91.225 and 91.227

Appendix C

ADS-B STATISTICAL ANALYSIS SYSTEM

Central American Corporation of Air Navigation Services

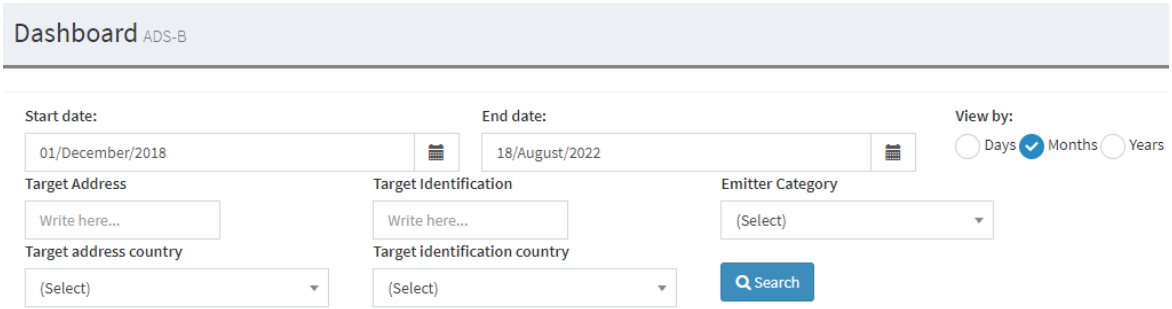
July 2022

ADS-B STATISTICAL ANALYSIS SYSTEM

Hereunder, the ADS-B Dashboard developed by COCESNA is illustrated, which allows, from the continuous recordings of ADS-B data, to graphically present the statistical results of the ADS-B messages that are formatted in Asterix Category 21, for each one of the ADS-B sensors installed in Central America.

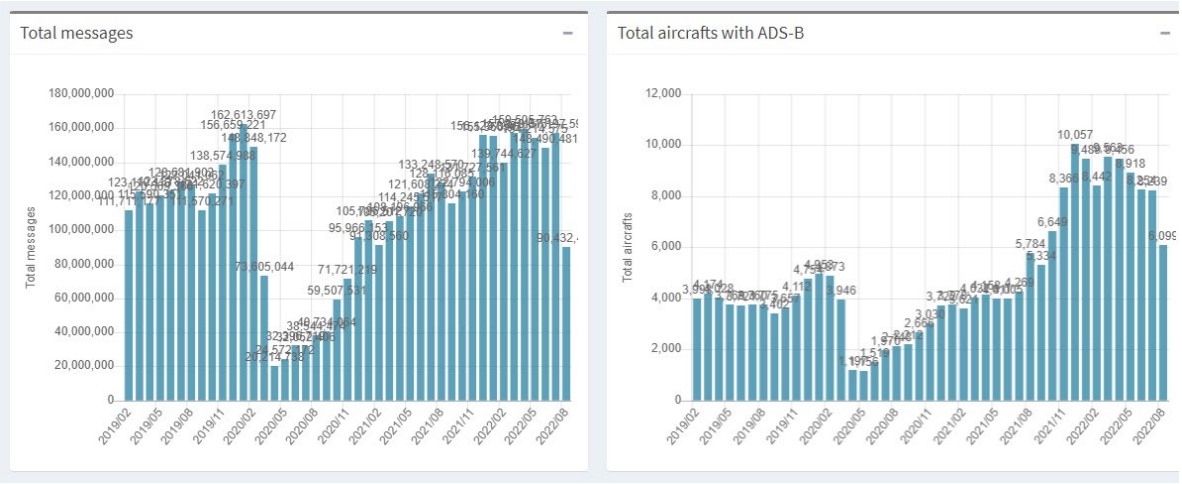
The main statistics of the Dashboard can be filtered by date and by the different identifiers of the aircraft and consolidated by time periods, see the following figure.

Fig 1. Main filters of the ADS-B Dashboard



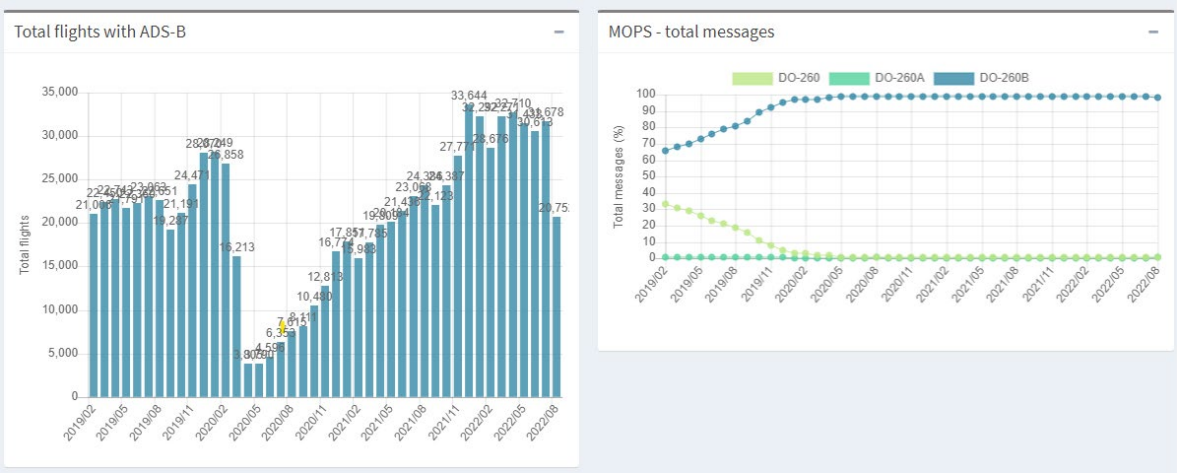
The following figure illustrates the statistics of total ADS-B decoded messages since 2019, including the number of aircraft with ADS-B.

Fig. 2. Total, de Mensajes decodificados y aeronaves con capacidad ADS-B



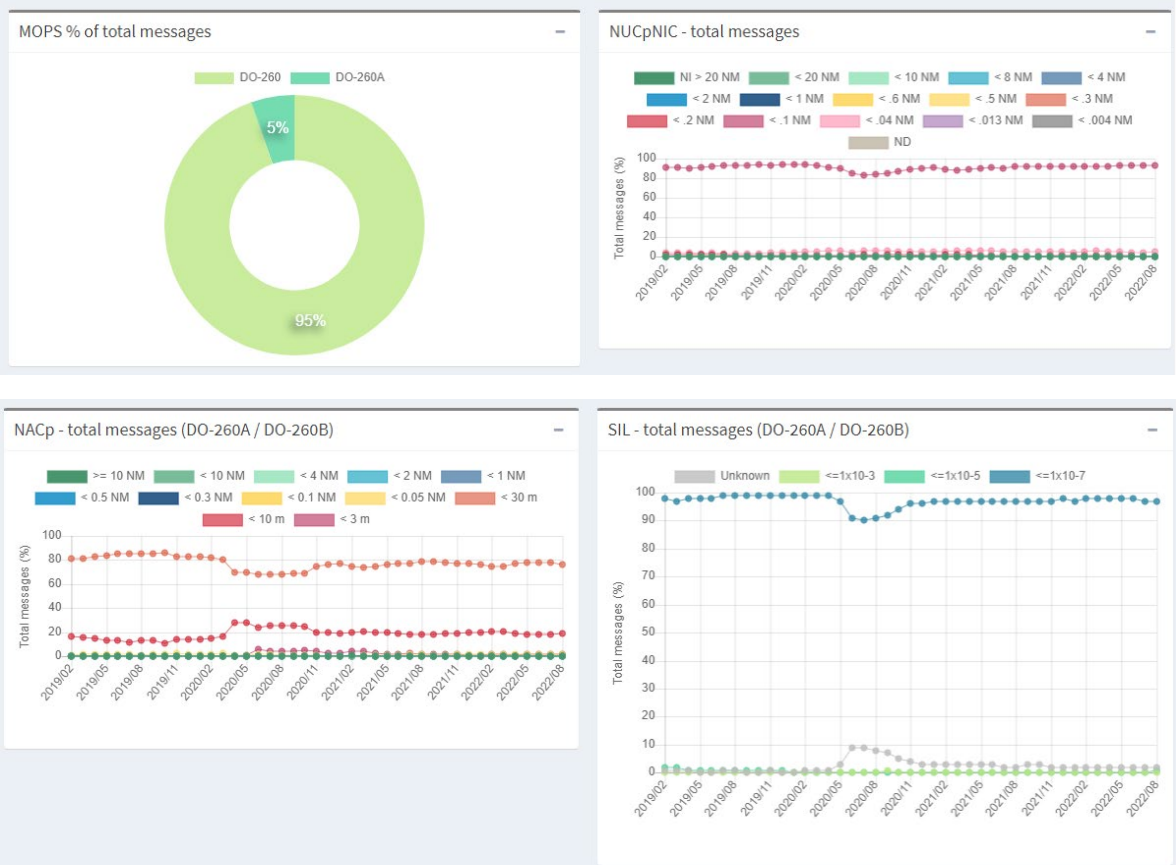
The above information can also be obtained by flight. The following figure illustrates the evolution of ADS-B avionics, where it can be seen how the DO-260B capacity grew significantly throughout 2019, due to the ADS-B mandate established by the FAA for January 1, 2020.

Fig. 3.- Statistics of flights with ADS-B capacity and evolution of ADS-B capacity (MOPS)



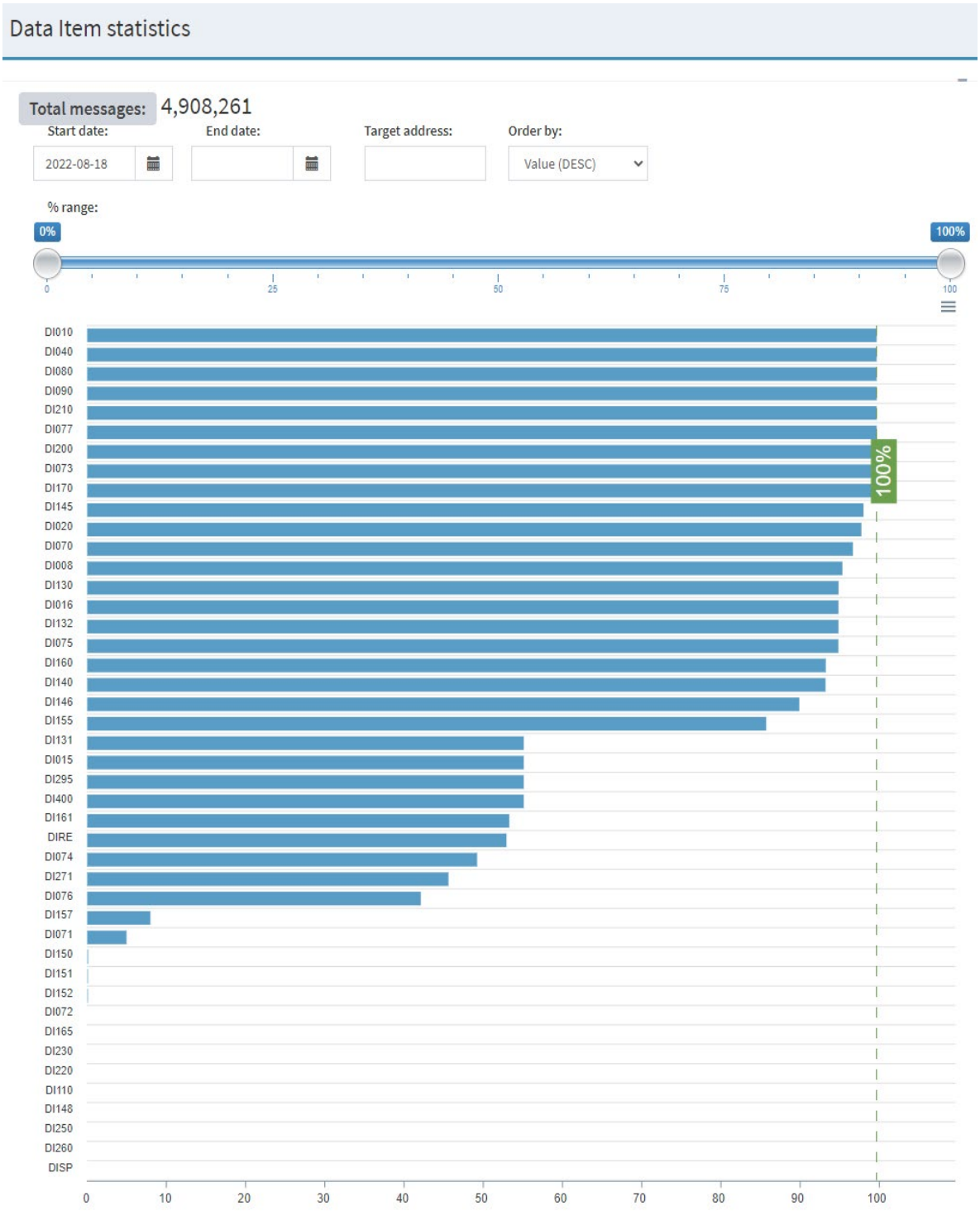
The following figures illustrate the statistics for the different figures of merit for ADS-B messages.

Fig. 4.- Statistics of the main ADS-B figures of merit



The system also allows an analysis of the main items of the messages formatted in CAT 21 and filtered by date and aircraft address.

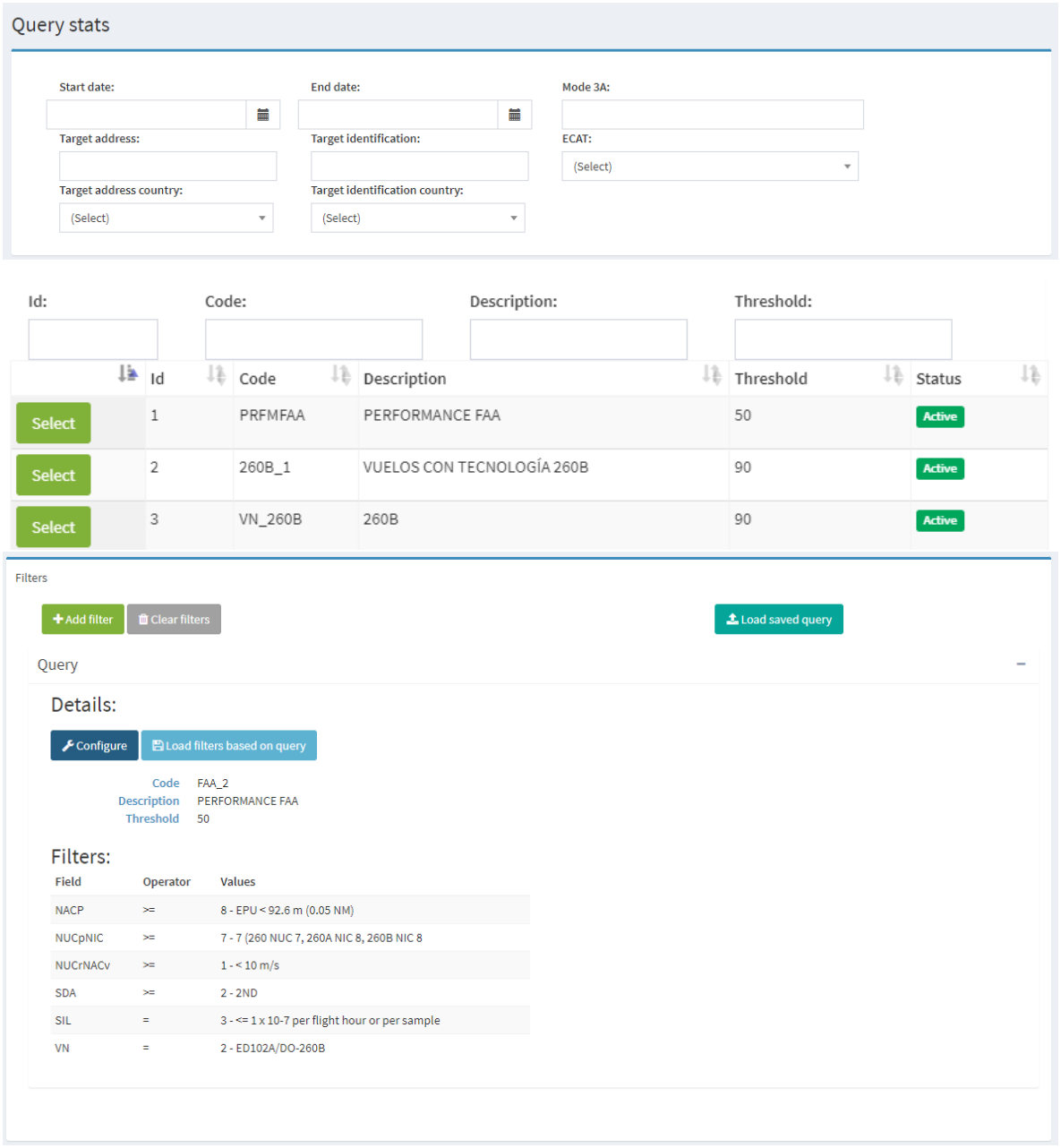
Fig. 5.- Data item statistics of ADS-B messages

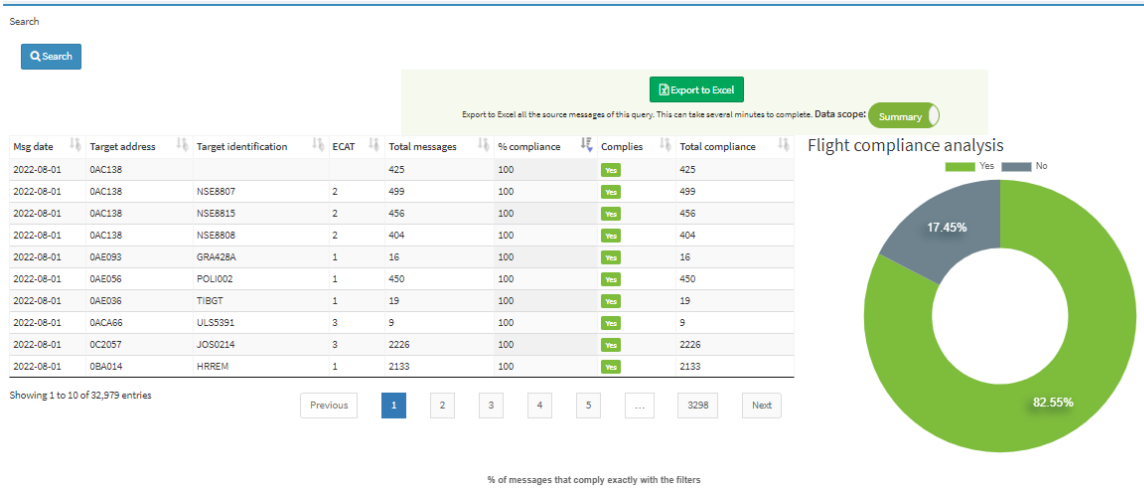


One of the main functions is to carry out analyzes filtered by dates and by the different identifiers of the aircraft, of the information obtained from the ADS-B messages.

This allows performance rules to be defined based on a selection of figures of merit and compliance thresholds according to the requirement of the airspace to be analyzed. An example is illustrated in the following figure to show the capabilities of such functionality.

Fig. 6. Data filtering by performance rules formed by ADS-B figures of merit.




Search
Search
Export to Excel
Export to Excel all the source messages of this query. This can take several minutes to complete. Data scope:
Summary
Msg date
Target address
Target identification
ECAT
Total messages
% compliance
Complies
Total compliance
2022-08-01 0AC138 425 100 Yes 425
2022-08-01 0AC138 NSE8807 2 499 100 Yes 499
2022-08-01 0AC138 NSE8815 2 456 100 Yes 456
2022-08-01 0AC138 NSE8808 2 404 100 Yes 404
2022-08-01 0AE093 GRA428A 1 16 100 Yes 16
2022-08-01 0AE056 POLI002 1 450 100 Yes 450
2022-08-01 0AE036 TIBGT 1 19 100 Yes 19
2022-08-01 0ACA66 ULS3391 3 9 100 Yes 9
2022-08-01 0C2057 JOS0214 3 2226 100 Yes 2226
2022-08-01 0BA014 HRREM 1 2133 100 Yes 2133
Showing 1 to 10 of 32,979 entries
Previous
1
2
3
4
5
...
3298
Next
Flight compliance analysis
Yes
No
17.45%
82.55%
% of messages that comply exactly with the filters

— END —