ADS-B/OUT/M — WP/14
29/07/19

Automatic Dependent Surveillance – Broadcast OUT Implementation Meeting for the NAM/CAR Regions (ADS-B/OUT/M)
Ottawa, Canada, 21-23 August 2019

Agenda Item 2: Update Status ADS-B Implementation for States
2.3 ADS-B trial statistics collection

STATISTICAL COMPILATION OF ADS-B MESSAGES RECEIVED IN THE WESTERN REGION OF THE HAVANA FIR

(Presented by Cuba)

EXECUTIVE SUMMARY	
This Working Paper presents a statistical analysis on the development of the ADS-B system implementation from 2015 to June 2019, in the aeronautical surveillance coverage zone within the Havana FIR.	
Action:	Suggested actions are presented in Section 4.
Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency
References:	• ICAO Doc 9924, ICAO Cir324, EUROCONTROL ASTERIX.

1. Introduction

1.1 For the study that is required for the implementation drills of the Automatic dependent surveillance – broadcast (ADS-B), Cuba has developed several tools that allowed the codification, storage and processing of data from different sources of its surveillances systems, such as RADAR, ADS-B and MLAT. This storage started since the end of 2014 to later obtaining this information that would serve as the basis for carry out the statistical analysis of the system performance.

1.2 In this Working Paper presents a proposal of statistical analysis on the development of the ADS-B system implementation between January 2015 and June 2019, taking into consideration la survey carried out by ICAO on the ADS-B data usage.

1.3 Following the aspects that must be considered in ICAO Doc 9871 for the evaluation of the surveillance system quality, the comparison criteria was selected to carry out a rational comparison as to: region of interest (e. g. Havana FIR), systems coverage, flight level, detection time, quality of the information, precision and accountability of the system.

2 Analysis

2.1 Menocal position was the base for the statistical analysis with an ADS-B receptor Version 1 (DO-260A), due that this position has all the data since 2015 to date and is data are more demonstrative to calculate the ADS-B implementation trend in the aircrafts. With this data was possible to assess:

- Coverage analysis
- Percentage of Aircraft Equipped for ADS-B Average of the distribution of the versions of on-board transponders of the aircrafts
- Reported Navigation integrity category (NIC) percentage
- Percentage of airlines and errors in the identification field

Coverage analysis

2.2 The evaluation of the theoretical coverage of the radiolocation field formed by ADS-B receptors that are located in San Julián, TMA, Menocal, Santa Clara, Camagüey, Holguín, Rx MLAT-Havana and Rx MLAT-Varadero, are shown in Figure 1 in the **Appendix** to this Working Paper.

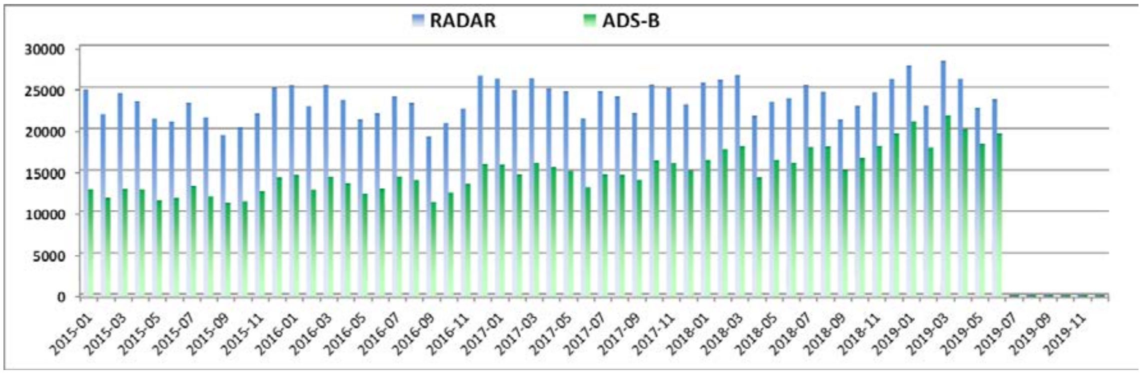
2.3 When is analysed the volume of theoretical coverage of the Menocal position, that depends of the geometrical and energy characteristics and that is compared with real data in a certain time interval, the images that prove the detection and range of the RADAR and ADS-B receptors are obtained. These are shown in Figures 3 and 4 in the Appendix to this Working Paper.

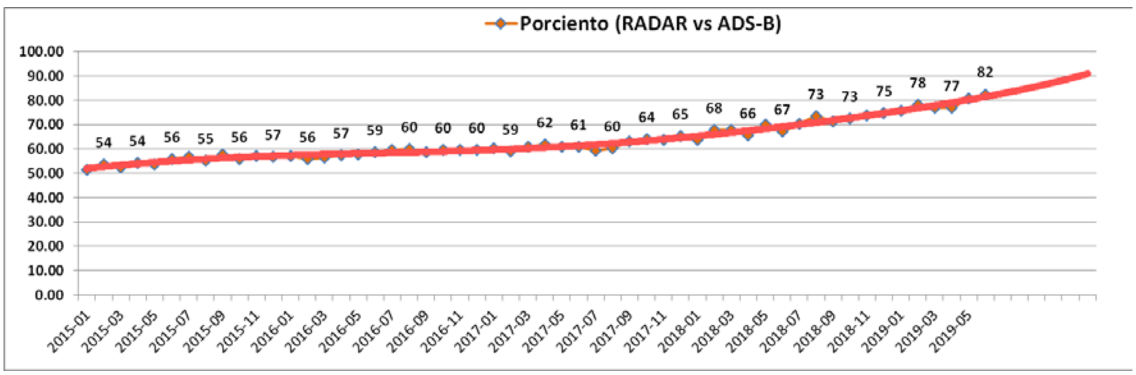
Percentage of aircraft equipped with ADS-B

2.4 From the Menocal surveillance position, in the study period 2015/01 – 2019/06, an average of **11138532 ASTERIX messages in Cat 48 from RADAR sources** (10 rpm back to the antenna) **and 61320773 messages in Cat 021** from a ADS-B receptor (1 second update) have processed per month, reaching a total monthly archive capacity of more than 3GBytes.

Monthly Average of detected aircrafts	2015	2016	2017	2018	2019
With RADAR	72407	70493	76157	86711	92329
With ADS-B	35868	37702	42772	55170	71342

2.5 After this data is processed, filtered and correlated, and having into account the coverage of each system, the statistics of how many aircrafts has been detected trough ADS-B and/or Radar is obtained, determining by this way the rising behaviour of its evolution, as shown in the next figure.

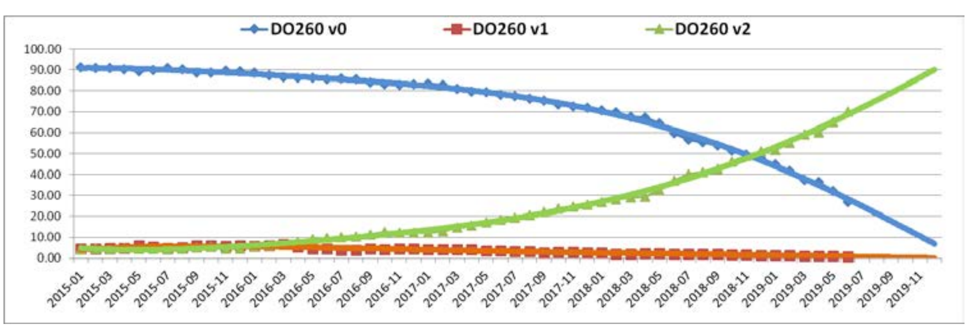




2.6 Currently, **84%** of aircrafts above 18000 feet are equipped with ADS-B. Following the uprising trend shown since 2015, it is estimated that in the end of 2019 90% of the aircrafts will be equipped with ADS-B.

Analysis of the distribution of the DO-260 transponder version

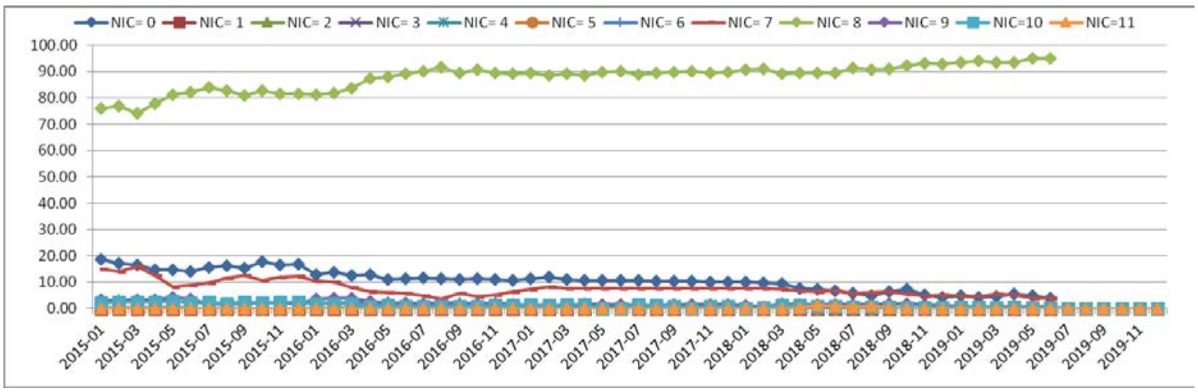
2.7 When quantifying the detected versions of this time interval, a considerable rise in the Version 2 equipment (DO-260B) is proved since 2016, meanwhile the use of Version 0 (DO-260) and Version 1 (DO-260) decreases, giving a perception that avionics is evolving from one version to the other.



2.8 Analysing this trend, it is estimated that in the end of 2019, **90%** of avionics will be Version 2 (DO-260B). Furthermore, the decrease of the use of Version 0 (DO-260) and 1 (DO-260A) is evident.

Analysis of the distribution of the Reported Navigation integrity category (NIC)

2.9 Navigation integrity category is obtained through decoding the I021/90 (Quality Indicators) element of the 021 category of the ASTERIX messages. In the statistical analysis is proven that the most common NIC is NIC=8.



2.10 Although this parameter depends of the geometry generated by satellites and aircrafts, a significant enhancement is evident in the rise of aircrafts with NIC=8 since 2015, and a decrease of NIC=0 (unknown characteristic).

Analysis of aircraft identification

2.11 Data from aircraft identification is obtained through decoding the element I021/170 (Target Identification) of category 021 of ASTERIX messages. This parameter has the characteristic that the obtained data must be codified as specified in Annex 10, Volume IV. This document explains that the aircraft identification will be used in the flight plan, and when the flight plan is not available it will be inserted in this subfield the aircraft registry. The characters code will be inserted in the higher origin unit (b6) and the aircraft identification will be transmitted starting by the first character of the left. Characters will be codified consecutively without interruption of code SPACE. All the spaces in the characters that have not been used with include the SPACE code in the final subfield.

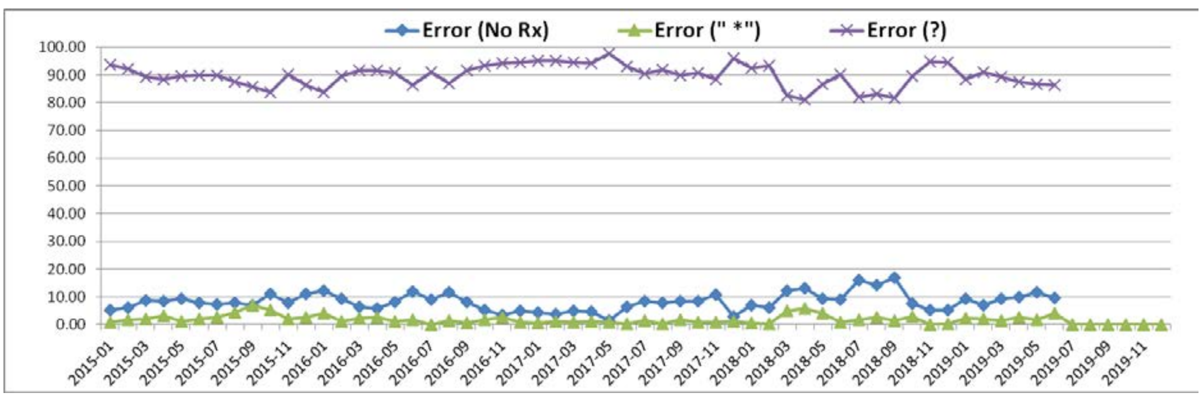
2.12 Following this standard, was possible to determine the association of the identification with the airlines database, with the registry database, and determine errors in the introduction of aircraft identification data, that have been processed and determined the following results:

Monthly identification average	2015	2016	2017	2018	2019
With flight plan (airlines)	11647.75	12767.17	14750.25	15129.17	18383.83
Without flight plan (registry)	173.33	241.92	294.00	375.33	357.42
Errors (without association)	346.00	471.33	556.00	388.92	382.14

2.13 Within the error average in the identifications, it has been proven that the most relevant are the following:

- Identification data not received
- Null identification or with spaces
- No flight names or wrong registries

Monthly identification errors average	2015	2016	2017	2018	2019
No identification Rx	27.08	35.75	32.58	39.17	42.33
Null ID or with spaces	8.58	7.25	5.08	8.83	10.33
Incorrect names	310.33	428.33	523.08	331.33	393.17



2.14 It is important to note that the identification of these errors is subject to the update databases trend.

3 Conclusions

3.1 The statistical analysis of the systems between 2015 and 2019 shows a **sustained growth of aircrafts with ADS-B transmitters**, determining in June 2019 that the average of aircrafts with ADS-B above 10000 feet is of **82.5%** and above 18000 feet of **84%.**

3.2 There is a trend of diminishing transponders with Version DO260 and increasing Version DO-260B.

3.3 The predominant Navigation integrity category is NIC=8.

3.4 There are errors in the introduction of the identifier ID that do not allow a correct correlation in the airlines coding.

4 Suggested actions

4.1 The Meeting is invited to:

a) note the statistics presented in this document;
b) analyse the results and the presented trends;
c) compare the presented data with the obtained in other States or organizations; and
d) make available to the national and IATA airlines the data related with errors that still occur in ADS-B transmissions.

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APPENDIX

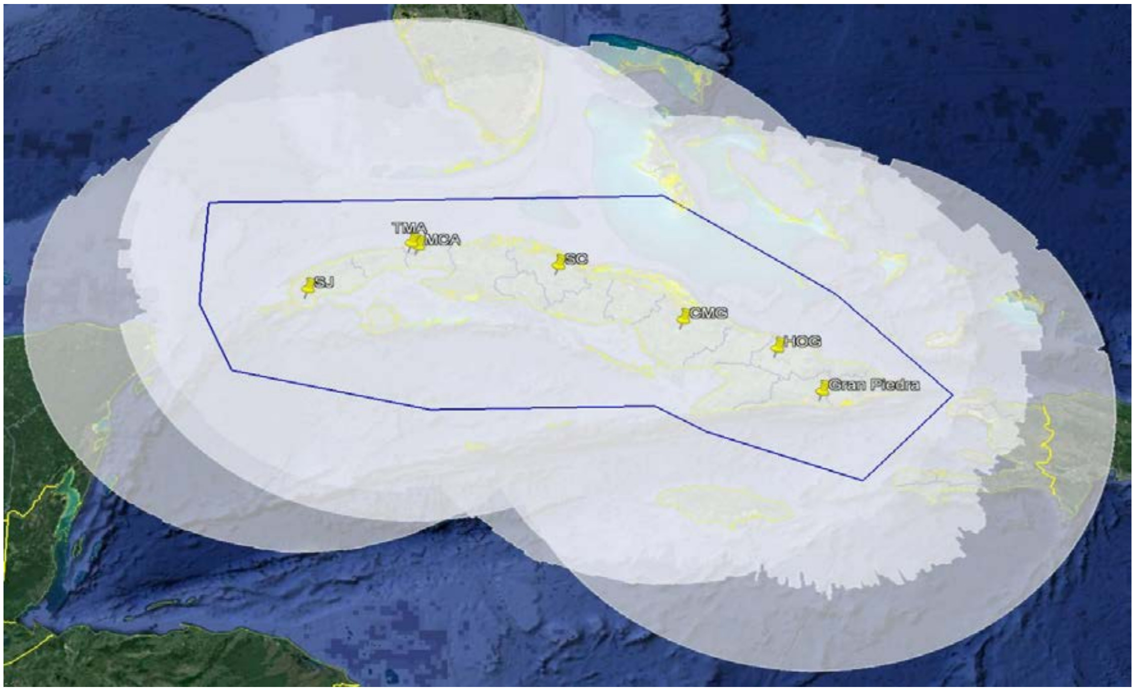
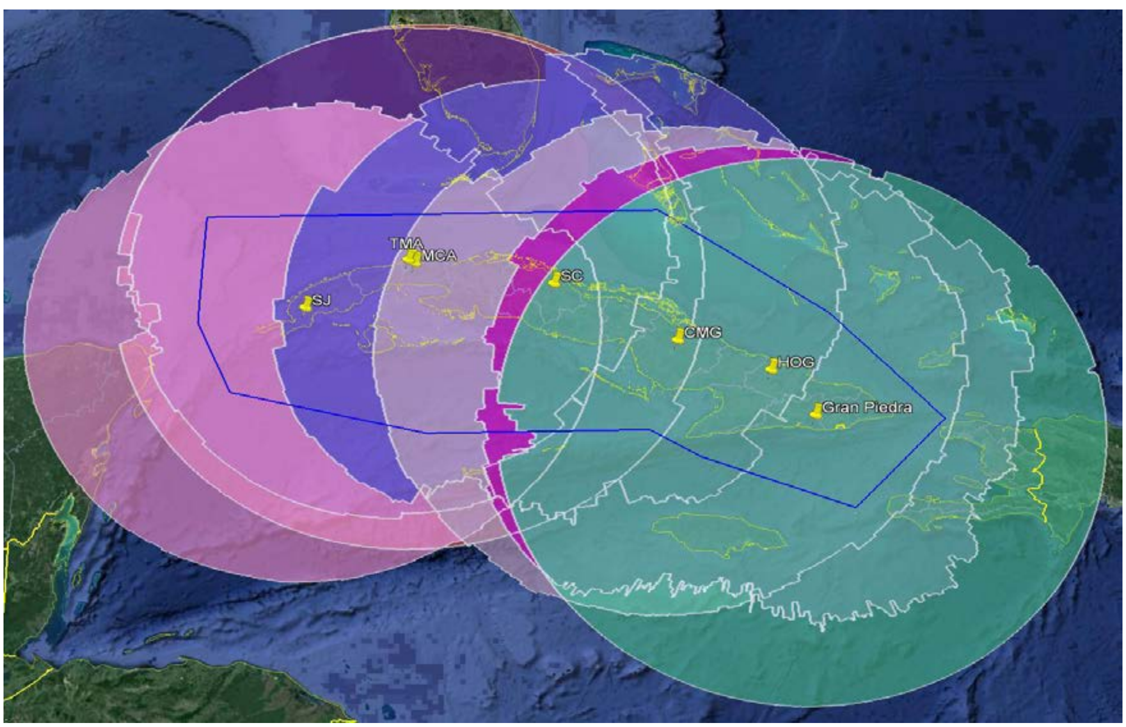
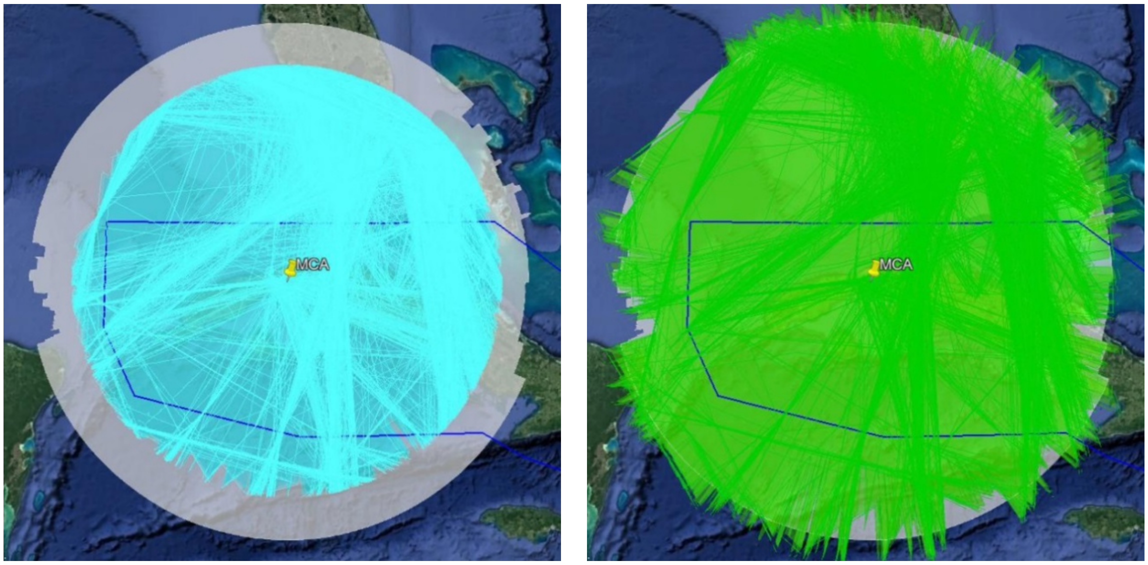


Figure 1. Assessment of the ADS-B coverage in the Havana FIR with FL300

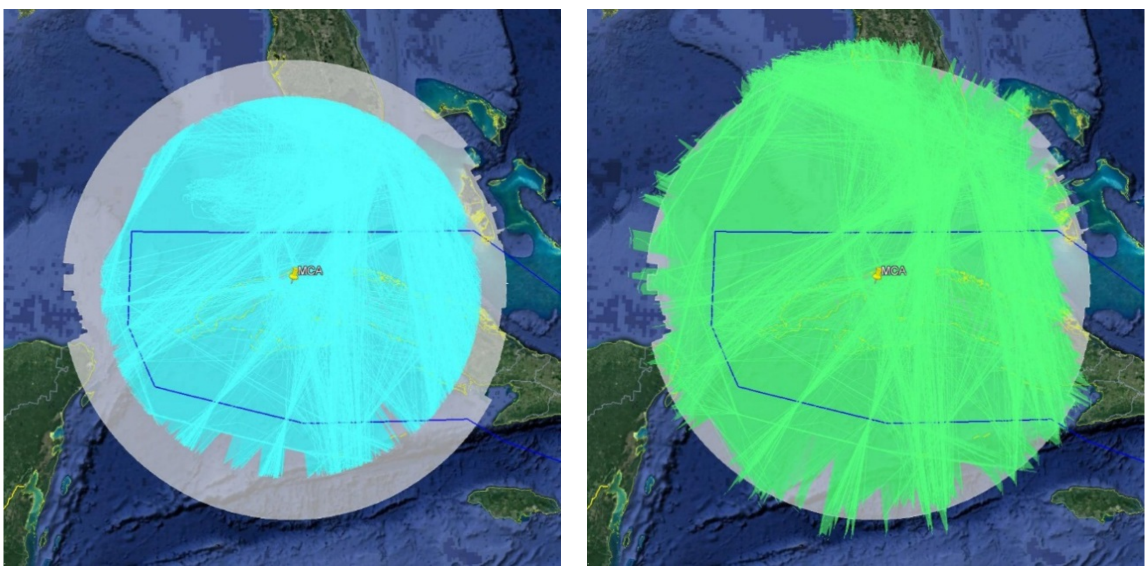


Figurea 2. Evaluation of ADS-B coverage in Havana FIR with FL400.



(a) (b)

Figure 3: Theoretical Coverage with FL400 and real data from Menocal position **(01/01/2015)**. (a) RADAR (b) ADS-B.



(a) (b)

Figure 4: Theoretical Coverage with FL400 and real data from Menocal position **(01/06/2019).** (a) RADAR

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