International Civil Aviation Organization

Fifth Meeting of the Surveillance Implementation Coordination Group (SURICG/5)

Web-conference, 22 – 24 September 2020

Agenda Item 3: Review of regional requirements for Surveillance in the e-ANP, Seamless ANS Plan and the reported implementation status

FAA'S OPERATIONAL EVALUATION OF SPACE-BASED ADS-B IN THE CARIBBEAN

(Presented by United States Federal Aviation Administration)

SUMMARY

This paper provides a status update of the Federal Aviation Administration's (FAA's) Operational Evaluation of Space-Based ADS-B (SBA) trials in the Caribbean. The paper provides an overview of the SBA trials, data analysis summary, and identified installation and coverage issues.

1. INTRODUCTION

1.1 Enhancing surveillance in oceanic airspace can provide improvements to air navigation services by reducing separation minima for optimum routing, depending on the communications and navigation services available in the airspace.

1.2 To date, the FAA has supported the development and maturation of the technology through development of proposed service performance requirements and modification of oceanic and en-route automation to accept Space-Based ADS-B (SBA) data. The FAA is working to assess the feasibility of the technology in order to implement a phased approach that will address technical, operational and safety issues pertinent to a potential long-term investment in SBA.

2. DISCUSSION

2.1 In the near term, the FAA is conducting an Operational Assessment of SBA to assess system performance in an operational environment. The objective is for the FAA to gain a sufficient understanding to enable better forecast of the long-term applications of SBA across a broader range of operational environments.

2.2 The Miami ARTCC (ZMA) offshore airspace has been determined by the FAA to be a suitable location for an initial evaluation of en-route surveillance and separation services using En-Route Automation Modernization (ERAM). Currently, ZMA offshore oceanic air traffic is monitored and controlled using instantaneous push-to-talk voice (i.e., VHF/UHF) communication and radar surveillance feeding ERAM.

2.3 Prior to 2020, ADS-B surveillance coverage in this airspace was limited to coverage provided by ground stations located on the Florida peninsula and Puerto Rico. There is a broad expanse

of airspace in the corridor between these areas where existing ADS-B terrestrial coverage is unavailable and where existing cooperative surveillance sources have reliability/redundancy issues.

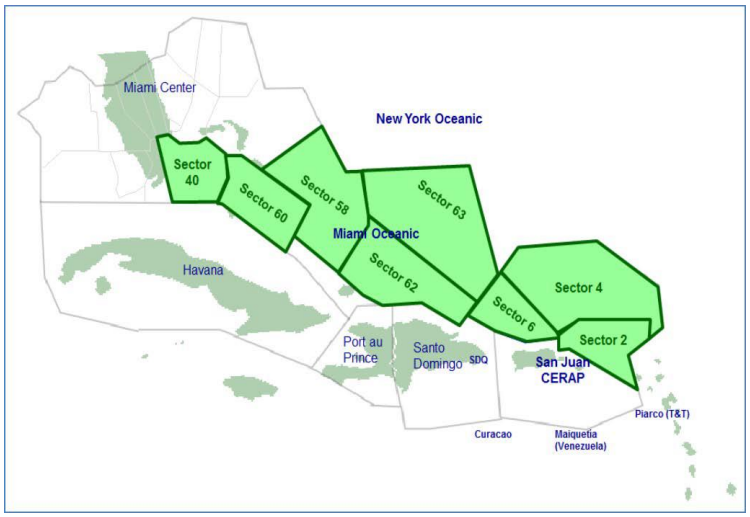

Figure 1: FAA Caribbean Airspace Sectors

2.4 The radar site at Grand Turk (GDT), in the Turks and Caicos Islands is a single point of failure impacting Sectors 62 and 63 due to the lack of terrestrial ADS-B or redundant surveillance coverage. Figure 2 illustrates the surveillance gap created by a GDT radar outage.

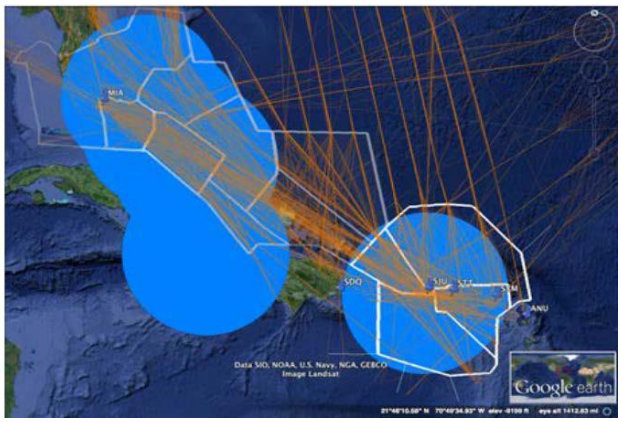

Figure 2: Grand Turk Surveillance Gap

2.5 As the FAA moves toward the Operational Assessment, Air Traffic Controllers at ZMA have identified a number of issues related to ADS-B installation and performance. Review of the received SBA data has highlighted the following issues:

1) Lack of detection for single antenna installations
2) Poor performance (e.g. low power) from diversity installations
3) Short periods of time with single satellite coverage.

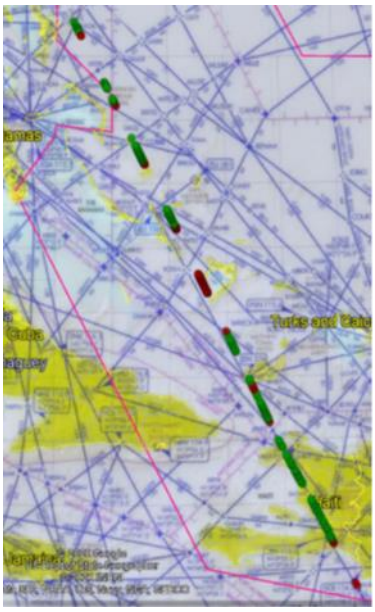

Figure 3: Bottom Only Installation

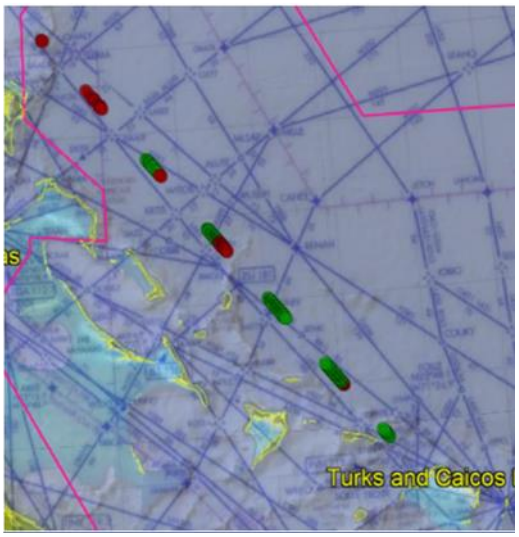

Figure 4: TCAS II aircraft potential low power or antenna issues.

2.6 An initial analysis of aircraft equipage (e.g., diversity, single antenna, ADS-B link version) flying through trial airspace was conducted. This analysis was done prior to ZMA's operational use of the SBA data previously scheduled for March 2020. Table 1 provides a breakdown of the data captured for January and February 2020.

Table 1: Aircraft Equipage

Category	Sub Category	January All Altitudes	February All Altitudes	February Above FL180	February Below FL180
Total Flights		**21298**	**18981**	**18150**	**831**
ADS-B		**97.5%**	**97.2%**	**97.8%**	**83.0%**
	LV2	97.3%	96.8%	97.5%	83.0%
	LV1	0.1%	0.1%	0.1%	0.0%
	LV0	0.1%	0.3%	0.3%	0.0%
	Diversity	83.0%	83.8%	85.1%	56.4%
	Lower	3.6%	3.4%	3.1%	9.0%
	TBD	10.9%	10.0%	9.6%	17.6%
Radar		**0.5%**	**0.8%**	**0.6%**	**4.6%**
Unknown		**2.0%**	**2.0%**	**1.6%**	**12.4%**

2.7 Note that in Table 1, Lower refers to single antenna aircraft and LV refers to ADS-B Out Link Version (e.g., LV2 = Link Version 2). In addition, MITRE assisted in analysing the data by using an avionics database they had created along with the ADS-B Performance Monitor to determine diversity versus single antenna installations.

2.8 As shown in Table 1, aircraft equipage between January and February 2020 did not vary significantly. In order for SBA to be used operationally, the following per aircraft update threshold requirements must be met

1) 8 second 97%
2) 30 second 99.9%

The 8 second 97% requirement is necessary to meet the RTCA DO-318 requirement for use of SBA in radar airspace. The 30 second 99.9% requirement is used by the FAA to track aircraft that have entered into a coasting condition, and is an "operational suitability" threshold defined by FAA controllers.

2.9 Using the above criteria, MITRE further examined aircraft performance above and below FL180 for the collected data on both a daily and hourly basis for the month of February 2020. Figure 5 provides a breakdown of the poor performing aircraft exceeding either the 8 second 97% or 30 second 99.9% update threshold requirement. A total of 4,849 aircraft were analysed of which 611 aircraft were identified as failing the 8 second 97% requirement, and 710 Aircraft failed the 30 second 99.9% requirement.

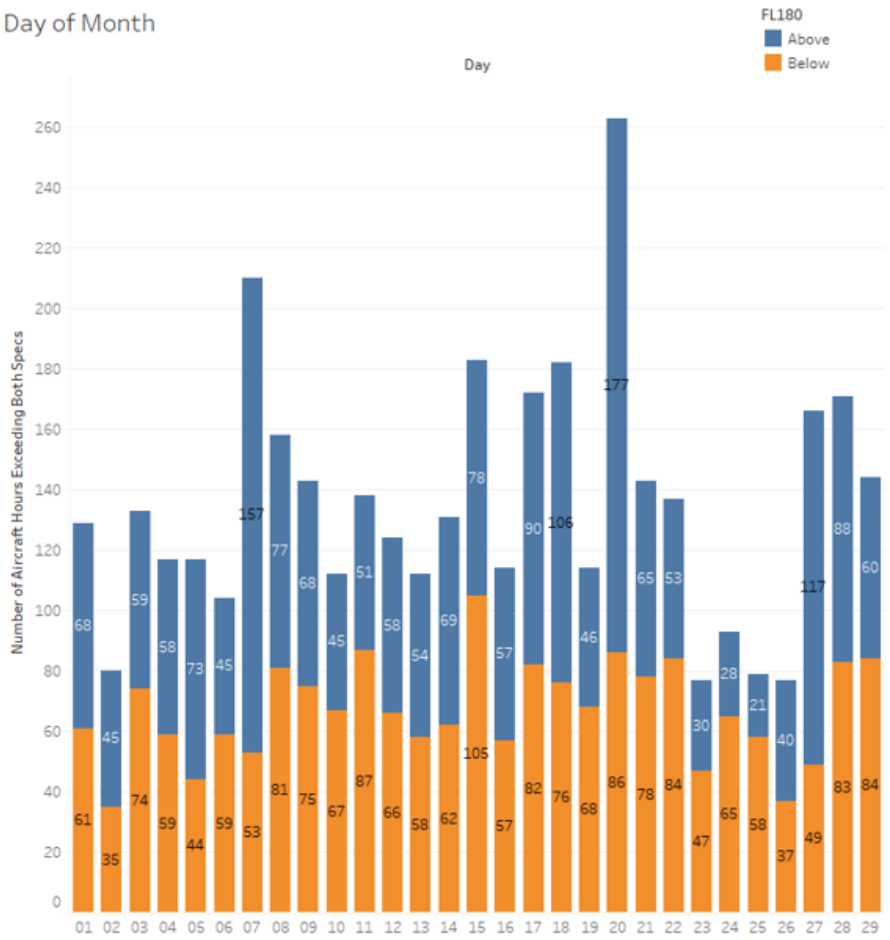

Figure 5: Number of Aircraft Hours Exceeding both specifications per Day of Month

2.10 After further analysis, the FAA determined that the use of the Single Antenna Flag (SAF) in the Aircraft Operational Status Message could not be utilized as a viable method to determine diversity. This was due to an inconsistency in how ADS-B manufacturers interpret the setting of the Single Antenna Flag (SAF) parameter described in DO-260B/ED-102A.

2.11 The TCAS Operational bit in the Airborne Aircraft Operational Status Message (ADS-B Version 2) was identified as a viable alternative to determine aircraft equipage. If set properly, the TCAS Operational bit would identify target aircraft equipped with TCAS II systems. Based on existing requirements, a TCAS II aircraft requires diversity antennas for the on-board transponder(s).

2.12 Figure 6 illustrates the average 8 second probability of detection (PD) distribution across the entire data set for TCAS II equipped aircraft for the months of February and March 2020.

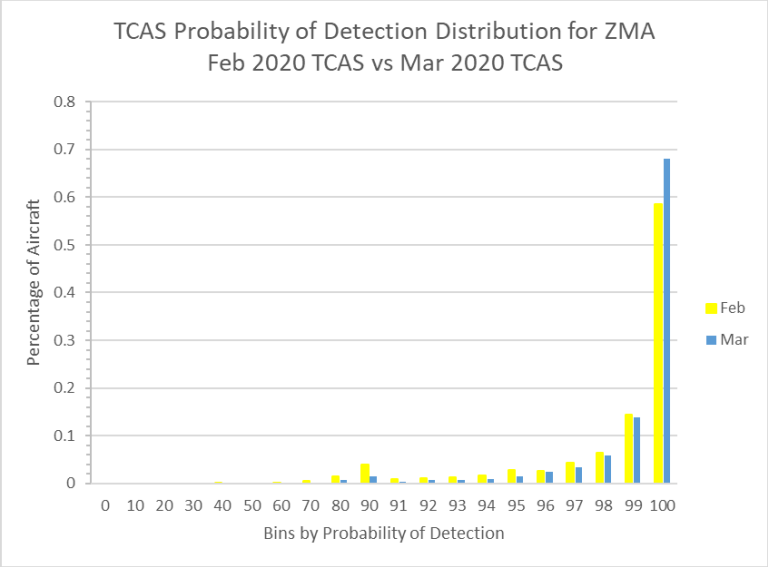

Figure 6: Probability of Detection Distribution for TCAS II Equipped Aircraft for ZMA

2.13 As shown in Figure 6, the PD distribution from February to March shows improvement for the lower end and 100% PD bins. Average PD across the system for both months is roughly the same. Note that at originally the data showed approximately 20% of the aircraft as having a probability of detection below 97%. This calculation did not take into account Aireon's system outage due to a planned maintenance update. After taking the outage into account, the probability of detection below 97% improved to approximately 18% for the month of February and 12% for the Month of March.

2.14 Using ADS-B received data, the FAA filtered the data for all targets that had over 500 ADS-B reports and a PD percentage less than 80% in both February and March 2020. For each aircraft on the resulting list that had operated within coverage of a U.S. ADS-B ground station, the FAA used the ADS-B Performance Monitor (APM) to compare SBA vs Terrestrial performance. Figure 7 is an example of this comparison.

Figure 7: FAA APM Terrestrial data (left); SBA data (right)

2.15 For diversity installations performing as expected, and no satellite outages in areas with single satellite coverage, the data has shown that SBA provides coverage necessary to properly surveil an aircraft as illustrated in Figure 8.

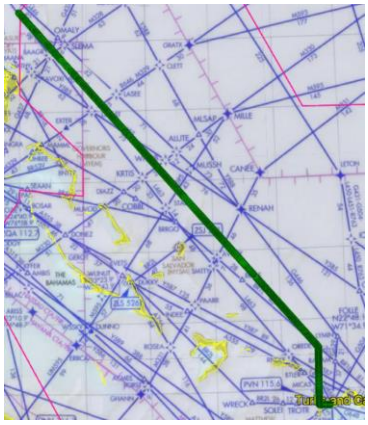

Figure 8: SBA Coverage into MBPV Airport

2.16 ZMA controllers have used the test area in Miami Center to determine the feasibility of using SBA data operationally to separate aircraft transiting through Sectors 62 and 63. During this testing, ZMA has determined the number of aircraft exhibiting issues exceeds the minimum acceptable level required to begin using SBA.

2.17 The FAA, in collaboration with Aireon, have identified the following as potential mechanisms to improve airspace performance:

1) Identify poor performing aircraft for remediation
2) Aireon to modify their system to optimize coverage and improve Pd
3) FAA implement an exclusion list for poor performing aircraft

2.18 The FAA will continue to compare data sets to identify noticeable improvements from receiver enhancements and operator avionics/installation corrections. Additionally, the FAA will compare aircraft performance captured by SBA in Miami oceanic airspace with data in Oakland oceanic airspace. This comparison may be helpful to identify potential trends in avionics/installation issues, equipage trends, and overall SBA system performance.

3. CONCLUSION

3.1 It is currently unknown as to which of the issues identified in Section 2.5 is the largest contributor to SBA detection issues. The FAA will continue to analyse data to identify improvements made from coordinated work with Aireon and relevant stakeholders. This analysis and coordinated work will assist in identifying the potential impact that each issue is having on aircraft detection.

3.2 FAA Lines of Business (i.e. ZMA, International office, etc.) will work with appropriate foreign counterparts to create an adequate Standard Operating Procedure (SOP) for handling aircraft with diversity antenna installations versus non-diversity installations.

3.3 The FAA will use the operational evaluation to evaluate SBA performance in mitigating impacts of GDT radar outages; augmenting existing terrestrial ADS-B coverage; and enabling potential route structure optimization.

4. ACTION BY THE MEETING

4.1 The meeting is invited to note the information contained in this paper.

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