



## Feasibility Study Aireon Space Based ADS-B in Indonesia

Taruna Jaya<sup>1</sup>, Lukie Hartono<sup>2</sup>, Feti Fatonah<sup>3</sup>, Indra Fadillah Mukti<sup>4</sup>, Dewa Putu Kidang Aritama<sup>5</sup>

<sup>1</sup>Direktorat Navigasi Penerbangan, <sup>2</sup>PT. IndoMega Teknologi, <sup>3,4,5</sup>Indonesian Aviation Polytechnic

---

### Abstract

Received: 2 Oktober 2024

Revised: 17 Oktober 2024

Accepted: 29 Oktober 2024

Space Based ADS-B technology is the latest technology from the development of conventional ADS-B which still uses a ground station. This technology is a system formed by satellites that are connected to each other as receivers of broadcast data from aircraft so that they can provide a wider level of surveillance in global airspace. This research aims to determine the extent of the implementation of Space Based ADS-B in Indonesia, including collaborating and comparing ADS-B data in oceanic areas and specific areas whose coverage is difficult to reach by ADS-B ground stations. This research uses a simulation-based analysis method using the Radar Analysis Support Systems for Real Time (RASS-R) application and the Radar Site Modeling (RSM) application and analyzes the comparison of the availability of ADS-B ground station and ADS-B space-based data. The results of this research show that the availability of data from space-based ADS-B can cover all regions of Indonesia.

**Keywords:** Space Based ADS-B, ground station ADS-B, surveillance, technology, coverage.

(\*) Corresponding Author: <sup>1</sup>taruna\_jaya@yahoo.com, <sup>2</sup>lukieh@indomegateknologi.com, <sup>3</sup>feti\_fatonah@yahoo.co.id, <sup>4</sup>indrafadillahmukti08@gmail.com, <sup>5</sup>kidangaritama04@gmail.com.

**How to Cite:** Jaya, T., Hartono, L., Fatonah, F., Mukti, I., & Aritama, D. P. (2024). Feasibility Study Aireon Space Based ADS-B in Indonesia. *Jurnal Ilmiah Wahana Pendidikan*, 10(24), 766-775. Retrieved from <https://jurnal.peneliti.net/index.php/JIWP/article/view/11527>

---

## INTRODUCTION

General safety protocols in air transportation modes are the main factor in providing aviation services. One form of service in the world of aviation is flight navigation services. In aviation navigation services, in order to improve aviation safety, a national aviation navigation order is needed, one of which is the air space served (*UU Nomor 1 Tahun 2009 Tentang Penerbangan*, n.d.)(PM 9 Tahun 2002 Tentang Tata Nangan Navigasi Penerbangan Nasional, n.d.). Good flight navigation services are realized by air navigation service providers supported by good flight navigation facilities.

In line with increasingly advanced technological developments, supporting facilities for aviation navigation services are also developing rapidly. The current use of aviation navigation equipment technology is a combination of conventional radar and ground station-based Automatic Dependent Surveillance-Broadcast (ADS-B). However, this equipment can only carry out real-time surveillance of approximately 30 percent of global airspace. Therefore, the use of technology in flight navigation services is starting to shift to the use of the latest surveillance



technology, namely Space Based ADS-B (*Feasibility Study Aireon Space Based ADS-B Di Indonesia*, n.d.).

Space Based ADS-B technology is the latest technology from the development of conventional ADS-B which still uses a ground station. This technology is a system formed by satellites that are connected to each other as receivers of broadcast data from aircraft so that they can provide a wider level of surveillance in global airspace (Baker, 2019)(Dolan et al., 2023).

In an effort to realize the provision of flight navigation facilities with adequate quality and quantity, the Directorate General of Civil Aviation together with Airnav Indonesia as a provider of flight navigation services in Indonesia and Aireon as a provider of Space Based ADS-B services conducted a Spaced Based ADS-B trial (Peraturan Pemerintah Republik Indonesia 77 Tahun 2012, 2012). This trial was carried out by installing 2 Service Delivery Points (SDP), namely at the Jakarta Air Traffic Center (JATSC) and the Makassar Air Traffic Center (MATSC) and carried out a trial phase for one year. This trial was carried out in the framework of the Space Based ADS-B implementation plan in Indonesia.

This research aims to determine the extent of the implementation of Space Based ADS-B in Indonesia, including collaborating and comparing ADS-B data in oceanic areas and specific areas whose coverage is difficult to reach by ADS-B ground stations from FIR JATSC and FIR MATSC. Apart from that, this research also aims to determine the level of need for Space Based ADS-B technology in Indonesia and assess the level of readiness (International Civil Aviation Organization, 2018). Therefore, a study was carried out on the implementation of Space Based ADS-B in Indonesia.

## **METHODS**

In this study, researchers compared ground station ADS-B and space-based ADS-B data based on coverage from simulation results, availability of ADS-B data in blankspot areas, and the amount of traffic that can be received by ADS-B. The ADS-B Ground Station coverage simulation was carried out to determine the location of surveillance blankspots in Indonesia at altitudes of 5,000 feet, 10,000 feet, 24,500 feet and 40,000 feet. This simulation was carried out using the Radar Analysis Support Systems for Real Time (RASS-R) Tools application for FIR MATSC and the Radar Site Modeling (RSM) application for FIR JATSC (Haase, 2014).

Next, researchers will analyze how the availability of ground station ADS-B and space-based ADS-B data compares. Researchers have collected several flight route data that pass through blank spot areas at the ADS-B Ground Station at altitudes of 5000 feet, 10,000 feet, 24,500 feet and 40,000 feet (Ali & Taib, 2019). This blankspot area is caused by limited signal reception range from the ADS-B ground station which can be caused by obstacles or areas where it is not possible to install an ADS-B ground station, such as oceanic areas (Wangchuk et al., 2021).

Finally, researchers will analyze the comparison of the amount of traffic between ADS-B ground stations and space-based ADS-B in Papua and the surrounding oceanic areas. The traffic data used is flight data at ground zero altitude up to 66,000 feet on September 18 2021 at 00:00 – 00:15 UTC.

## RESULTS & DISCUSSION

### 1. ADS-B coverage based on simulation results

The following are the simulation results of ADS-B and space-based ADS-B ground station coverage at altitudes of 5.000 feet, 10.000 feet, 24.500 feet, and 40.000 feet:



Figure 1. ADS-B ground station coverage at an altitude of 5.000 feet

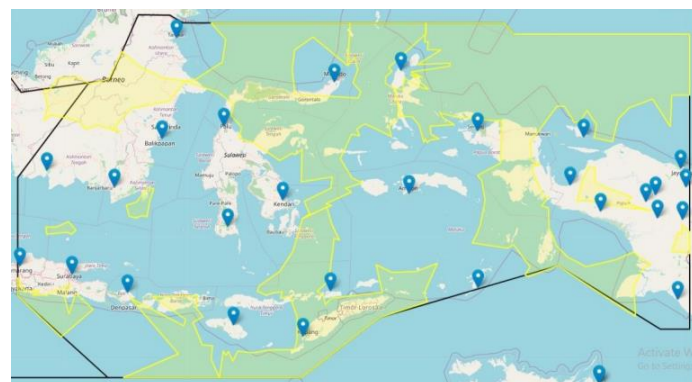


Figure 2. ADS-B ground station coverage at an altitude of 10.000 feet



Figure 3. ADS-B ground station coverage at an altitude of 24.500 feet



Figure 4. ADS-B ground station coverage at an altitude of 40,000 feet



Figure 5. Space based ADS-B ground station coverage at ground zero altitude up to 66.000 feet

Based on this image, we can see that there are lots of blank spots at heights of 5.000 feet, 10.000 feet, 24.500 feet and 40.000 feet. This blank spot is caused by obstacles on the land surface or in oceanic areas where ground stations cannot be installed. Meanwhile, with space-based ADS-B, we can see that it has coverage that can reach all regions of Indonesia at ground zero altitudes up to 66.000 feet.

## 2. Availability of ADS-B data in the blankspot area

The following are the results of coverage analysis from several flights that passed through the blankspot area at altitudes of 5.000 feet, 10.000 feet, 24.500 feet and 40.000 feet.

### a) 5.000 feet

On a route with an altitude of 5.000 feet, researchers sampled flight data IW1336 or WON1336 on September 18 2021 with the Kendari to Wangiwangi Island flight route. On flight IW1336, the ADS-B Ground Station system could only monitor the movement of the aircraft while it was still at Kendari Airport up to the last coordinates with latitude values - 4.9136781692505 and longitude 123.29286575317, at 01:32:27 UTC with an altitude of 6,800ft. Meanwhile, the Space Based ADS-B system can monitor the aircraft's flight from Kendari Airport to landing at Matahora Wangiwangi Airport. So, the difference between the latest ADS-B Ground Station data and the Space Based ADS-B system is 11 minutes 42 seconds.



Figure 6. Flight Route IW1336

Description:

Green line: MATSC and Space Based ADS-B flight data

Blue Line: Space Based ADS-B flight data

b) 10.000 feet

On a route with an altitude of 10.000 feet, researchers sampled flight data IW1267 or WON1267 on September 18 2021 with the Nias Island to Medan flight route.

On this flight the ADS-B Ground Station system was unable to monitor the aircraft since it was at Nias Island Airport and was only able to monitor the aircraft's movements when the aircraft landed at coordinates 2.3984956741333, 98.182497024536 with an altitude of 15.775ft. The ADS-B Ground Station was again unable to monitor the movement of the aircraft when landing until the aircraft stopped on the apron of Kualanamu Airport, Medan. Meanwhile, the Space Based ADS-B system can monitor the aircraft's flight route in its entirety from when the aircraft is at Nias Island Airport to landing and parking on the apron of Medan's Kualanamu Airport.



Figure 7. Flight Route IW1267

Description:

Red line: JATSC and Space Based ADS-B flight data.

Blue line: Space Based ADS-B flight data

c) 24.500 feet

On a route with an altitude of 24.500 feet, researchers sampled flight data VOZ1918 on September 14 2021 with the Christmast Island to Cocos Island route via FIR Indonesia. In the Space Based ADS-B system, the entire flight route which lasts 1 hour 43 minutes 50 seconds can be monitored while in the Indonesian FIR up to 100 Nm outside the Indonesian FIR limit at a height of 22.250 feet. Meanwhile, on the ADS-B Ground Station system, this flight route cannot be monitored at all.



Figure 8. Flight Route VOZ1918

Description:

Red line: JATSC and Space Based ADS-B flight data

Blue line: Space Based ADS-B flight data

d) 40.000 feet

On a route with an altitude of 24.500 feet, researchers sampled flight data from ETH3600 on October 18 2021 with the Addis Abeba or Ethiopia route to Soekarno-Hatta International Airport. On this flight, the Space Based ADS-B system was able to monitor the movement of the aircraft when it was 100Nm in the Oceanic area before entering the Indonesian FIR area at coordinates 2.0059704780579, 90.335919857025 with an altitude of 41.225ft at 08:31:07 UTC.

Meanwhile, the new Ground Station ADS-B system can monitor the movement of the aircraft at coordinates -2.8552007675171, 100.29433965683 with an altitude of 41.425ft at 10:00:24 UTC, so there is a difference in data reception between the Ground Station ADS-B and Space Based ADS-B systems for 1 hour 29 minutes 7 seconds.

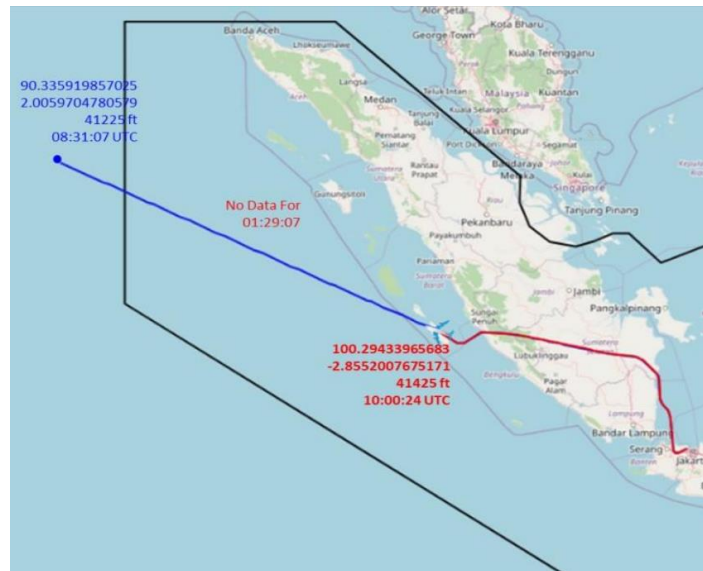


Figure 9. ETH3600 Flight Route

Description:

Red line: JATSC and Space Based ADS-B flight data

Blue line: Space Based ADS-B flight data

### 3. Comparison of the amount of traffic

The following is a comparison of traffic data in Papua and the surrounding oceanic region at an altitude of ground zero to 66.000 feet on September 18 2021 at 00:00 – 00:15 UTC.

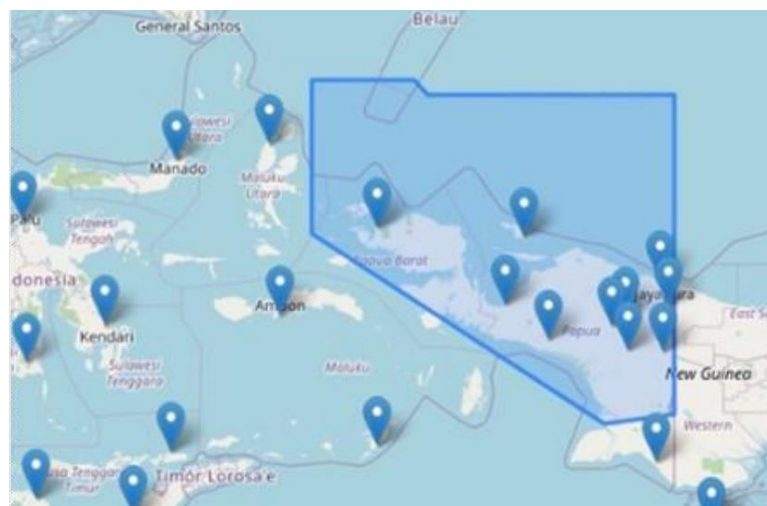


Figure 10. Area for comparative analysis of the amount of traffic between Ground Station ADS-B and Space Based ADS-B

The total amount of traffic received by Ground Station ADS-B MATSC and Space Based ADS-B after data processing is carried out, there are differences in the amount of flight traffic as in the table below:

Table I. Comparison of Ground Station ADS-B and Space Based ADS-B traffic in the assessed analysis area

No	Flight number	Space-based ADS-B data		GS ADS-B MATSC data	
		Available	Not Available	Available	Not Available
1	PKTVI	Available	Not Available	Available	Not Available
2	GIA657	Available	Not Available	Available	Not Available
3	BTK6186	Available	Not Available	Available	Not Available
4	TMG082	Available	Not Available	Available	Not Available
5	WON1613	Available	Not Available	Available	Not Available
6	LNI796	Available	Not Available	Available	Not Available
7	PKSNA	Available	Not Available	Available	Not Available
8	PKMPF	Available	Not Available	Not Available	Not Available
9	PKYSG	Available	Not Available	Not Available	Not Available
10	PKRVG	Available	Not Available	Not Available	Not Available
11	PKSNG	Available	Not Available	Not Available	Not Available
12	PKSMW	Available	Not Available	Not Available	Not Available
13	PKDLT	Available	Not Available	Not Available	Not Available
14	PKRKD	Available	Not Available	Not Available	Not Available
15	PKSNW	Available	Not Available	Not Available	Not Available
16	ZGR	Available	Not Available	Not Available	Not Available
17	PKSNR	Available	Not Available	Not Available	Not Available
18	PKSNV	Available	Not Available	Not Available	Not Available
19	CATS82	Available	Not Available	Not Available	Not Available
20	CATS84	Available	Not Available	Not Available	Not Available
21	WON5040	Available	Not Available	Not Available	Not Available

Based on the data availability table, we can see that among the 21 aircraft movements that occurred over the Papuan sky at an altitude of ground zero to 66.000 feet on September 18 2021 at 00:00 – 00:15 UTC, the ADS-B ground station could only monitor seven just movement. Meanwhile, with space-based ADS-B, all of these movements can be monitored well.

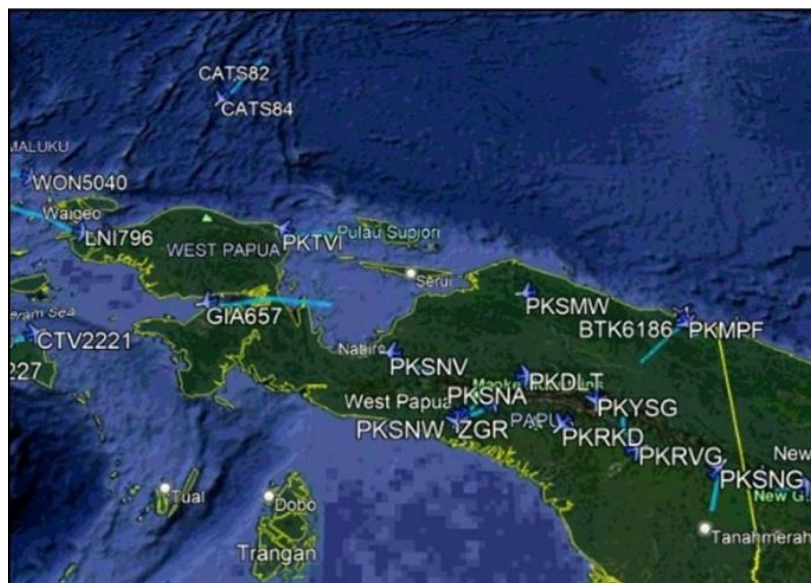


Figure 11. Number of Space Based ADS-B traffic in oceanic areas and Papua from ground zero to 66,000 feet

## CONCLUSION

### A. Technological Aspects

Several superior aspects of Space Based ADS-B when compared to Ground Station ADS-B, include:

- 1) System installation and installation is more flexible and faster, whereas installation of the ADS-B Ground Station takes longer.
- 2) If there is a disturbance or damage to the Space Based ADS-B system at the site, there is systems support to overcome the problem, whereas if there is a disturbance or damage to the Ground Station ADS-B system, repairs are carried out manually by the user.
- 3) The Space Based ADS-B technology system has a longer lifespan in use compared to ADS-B Ground Station equipment and systems.
- 4) Coverage Space Based ADS-B can cover 100 percent of Oceanic and land areas with altitudes ranging from ground zero to 66,000 feet, while Ground Station ADS-B has limited coverage in terrestrial areas.

### B. Environmental Aspects

In the environmental aspect, the ADS-B Ground Station system requires many ADS-B receivers to be installed in certain areas to cover the area you want to monitor, which can experience interference if routine maintenance and checking is not carried out, especially if installed on islands or mountainous areas that are not has a source of electrical power for continuous operation, while the Space Based ADS-B system can monitor all flights in the Indonesian FIR region distributed using SDP devices which can be directly integrated into the ATC Automation system.

### C. Value Benefit Analysis (Ground Station ADS-B dan Space Based ADS-B)

Table II. Value Benefit Analysis

NO	<i>Ground Station ADS-B</i>	<i>Aireon Space Based ADS-B</i>
1	ADS-B receiver installed only on land area and limited coverage because of the terrestrial area.	There are 34 ADS-B receivers on one satellite, while the total number of satellites in operation is 66 satellites with 100 percent coverage covers terrestrial and oceanic areas.
2	On site Installation takes time and cost to location for installation	Easy, flexible and fast installation
3	There is no support system, if an error or disturbance occurs in the system repairs are made by the user	Have a support system, if any errors or disruptions in the repair system can be done by the Space service provider Based on ADS-B
4	Shorter device life compared to Space Based ADS-B and Expensive initial costs and maintenance cannot be known	Device life is longer than Ground ADS-B station and low initial cost
5	System capabilities limited observation/surveillance in oceanic and mountainous areas	Observation/surveillance system capabilities covers the entire Indonesian FIR area so it can provide complete safety which is faster for last point information event coordinates for Search needs And Rescue quickly and precisely.
6	Unable to provide flight data thoroughly if an incident occurs or accidents in good blank spot areas for SAR purposes or investigation	Can provide flight data directly detailed and comprehensive if an incident occurs or accident at a point in the blank spot area needed for SAR purposes or accident analysis investigation.
7	The ADS-B system has vulnerabilities disrupted if a disaster occurs terrestrial regions ADS-B receivers such as earthquake, flood, bad weather, landslide or terror at the location.	The system is safer because of the ADS-B receiver installed on the satellite and can be accessed at any time without being hindered if a disaster occurs earthquake, flood, bad weather, landslide or terror at the location.

## REFERENCES

- Ali, B. S., & Taib, N. A. (2019). A Study on Geometric and Barometric Altitude Data in Automatic Dependent Surveillance Broadcast (ADS-B) Messages. *Journal of Navigation*, 72(5), 1140–1158. <https://doi.org/10.1017/S0373463319000201>
- Baker, K. (2019). Space-Based ADS-B: Performance, Architecture and Market. *2019 Integrated Communications, Navigation and Surveillance Conference (ICNS)*, 1–10. <https://doi.org/10.1109/ICNSURV.2019.8735307>
- Dolan, J., Garcia, M. A., & Sirigu, G. (2023). Aireon Space Based Aircraft Position Validation And Multilateration Solution. *2023 IEEE/AIAA 42nd Digital Avionics Systems Conference (DASC)*, 1–10. <https://doi.org/10.1109/DASC58513.2023.10311332>
- Feasibility Study Aireon Space Based ADS-B di Indonesia*. (n.d.). Ministry of Transportation, PT. IndoMega Teknologi, Aireon.
- Haase, G. (2014). *Simulation of radar reflectivities using Hirlam forecasts*. <https://www.researchgate.net/publication/228874079>
- International Civil Aviation Organization. (2018). *International Civil Aviation Organization Annex 11*.
- Peraturan Pemerintah Republik Indonesia Nomor 77 Tahun 2012*. (2012).
- PM 9 Tahun 2002 Tentang Tata Navigasi Penerbangan Nasional.
- UU Nomor 1 Tahun 2009 Tentang Penerbangan*. (n.d.).
- Wangchuk, K., Sangay, Naganawa, J., Adhikari, D., & Gayley, K. (2021). *ADS-B Coverage Design in Mountainous Terrain* (pp. 327–336). [https://doi.org/10.1007/978-981-33-4669-7\\_19](https://doi.org/10.1007/978-981-33-4669-7_19)