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**THE APPLICATION AND BENEFITS OF SPACE-BASED ADS-B DATA IN THE  
DEVELOPMENT OF SAFETY PERFORMANCE INDICATORS IN SUPPORT OF ICAO'S  
DATA-DRIVEN APPROACH TO ENHANCING GLOBAL AVIATION SAFETY**

(Presented by the Flight Safety Foundation)

**EXECUTIVE SUMMARY**

This paper describes the application of space-based ADS-B data in developing Safety Performance Indicators (SPIs), in support of ICAO's objective towards data-driven approach to enhancing global safety. The recent developments of space-based ADS-B in real-time tracking of aircraft and the provision of air traffic services in selected airspaces provides the opportunity for the global community to leverage this capability to advance aviation safety. This capability has been supported and enabled by ICAO over the recent past, specifically as related to separation standards development. This paper describes the potential SPIs that can be generated using this data, where when combined with other contextual information, can support ICAO strategic goal of a data driven approach to global aviation safety and expanding the use of industry programs (Goal 5) of the 2020-2022 *Global Aviation Safety Plan* (GASP). This paper describes initial SPIs under consideration, the governance process and next steps.

<i>Strategic Objectives:</i>	This working paper relates to the Safety Strategic Objective.
<i>Financial implications:</i>	None identified.
<i>References:</i>	Annex 6 — <i>Operation of Aircraft</i> Annex 11 — <i>Air Traffic Services</i> Annex 14 — <i>Aerodromes</i> Annex 19 — <i>Safety Management</i> <i>Safety Management Manual (SMM)</i> (Doc 9859) <i>Global Aviation Safety Plan (GASP)</i>

## 1. INTRODUCTION

1.1 Traditional air traffic radar surveillance and ground-based Automatic Dependent Surveillance-Broadcast (ADS-B) surveillance systems provide tracking of aircraft. Radar surveillance have been used for many decades to track aircraft and provide a capability for aircraft separation assurance. Ground-based ADS-B surveillance system have been more recently deployed in regions around the world. This ground-based system relies on aircraft broadcasting their identity, a precise Global Positioning System (GPS) position and other information derived from on-board systems.

1.2 Ground-based systems, radar or ground-based ADS-B, leave a large portion of global airspace without any real-time air traffic surveillance coverage. The technology of these systems operates via “line-of-sight” and are limited by physical obstructions such as terrain and infrastructure or by vast water bodies, remote areas and polar regions and by proximity to the antenna location. These obstructions significantly decrease a radar or receiver range and ability to receive transponder emitted signals. Therefore, historically there have been significant limitations of receiver coverage in some geographic regions.

1.3 Space-based surveillance, on the other hand, which relies on ADS-B signals emitted by aircraft and received by satellites, eliminates many of these blind spots, enabling more complete surveillance coverage of global airspace. Due to increased accuracy, space-based surveillance has the potential to enable real-time separation services, enabling increased safety, precise aircraft locations, improved search and rescue response, reduction in gross navigation errors, improved cross-border safety and faster pilot/controller communication, and enabling the archiving of vast amount of aircraft trajectory data for analytics.

1.4 Space-based ADS-B uses data from receivers that are placed on satellite constellations in space to track aircraft as they traverse the airspace. Aircraft will need to have on-board ADS-B out transponders. ADS-B provides a highly accurate tracking of aircraft anywhere on the surface of the earth. The accuracy of aircraft position using ADS-B is known to be equivalent or better than radar, enabling real-time air traffic separation in many airspaces around the world. Additionally, space-based aircraft tracking is not affected by weather or impacted by natural phenomena or geopolitical influences and as such formed a unique surveillance to complement existing ground-based radar and/or ADS-B network currently used for safety analysis and ATS separation services.

## 2. SPACE-BASED ADS-B DERIVED TRAJECTORIES

2.1 Space-based surveillance capability enables the development of highly accurate aircraft trajectories as demonstrated already with ground based ADS-B data in various locations. ADS-B when combined with other contextual information, including weather, airport and airspace configuration, will allow for a better understanding of causal and classification analysis of leading indicators of risk.

2.2 These metrics provide safety professionals with the ability to track and trend safety risks on a global scale as well as in areas where they were previously undetectable. Additionally, the space-based surveillance-based metrics enable the assessment and tracking of the effectiveness of mitigations while providing a quantitative input to the safety risk management process, per Doc 9859.

### **3. SPACE-BASED SURVEILLANCE AIRCRAFT TRAJECTORY AND COMPLIANCE INFORMATION**

#### **3.1 Space-based ADS-B trajectory derived parameters**

3.1.1 Because of the highly accurate flight trajectories enabled by space-based ADS-B high update rate data transmission, useful trajectory parameters can be generated to include ground speed, vertical speed, and heading. Flights are identifiable by operator, tail number, ICAO hex code and date/time. The following are examples of associated parameters that can be derived: (a) track curvature, (b) along track distance, (c) climb rate, (d) pressure altitude, (e) ground speed, (f) ground acceleration, and (g) track heading.

#### **3.2 Terrain safety information**

3.2.1 When combined with high quality terrain and elevation information, space-based ADS-B trajectory information can enable the analysis of risk of collision with terrain. High quality global terrain and elevation information is readily available through a variety of sources and can be integrated with space-based ADS-B trajectory information.

#### **3.3 Collision safety information**

3.3.1 A global Space-based ADS-B capability will be able to provide important non-trajectory safety information. For example, Traffic Collision Avoidance System (TCAS) Resolution Advisories (RAs) can be received via a RA broadcast message included in version two of the 1090 Extended Squitter ADS-B MOPS. This data – when available globally – can help understand collision risk scenarios and identify areas with frequent RA activity. Space-based ADS-B can monitor TCAS data received via ADS-B messages, including oceanic regions outside of radar coverage that would currently go unnoticed unless reported by the flight crew.

3.4 Space-based ADS-B Aircraft trajectories can be archived on a daily basis to create a growing trajectory data set that can be used for statistical analysis. Since the aircraft trajectories are identified, they can be readily combined with other contextual and pertinent information such as weather, airspace and aerodrome information, surface infrastructure information (e.g. runways), air traffic procedures (e.g. area navigation), aircraft equipage (e.g. data link, RNAV/RNP), and engine information. The resulting data set, which has aircraft trajectory combined with related flight contextual data can be analyzed and mined for operational and safety issues in support of SMS requirements in Doc 9859.

3.5 Initial Risk Area measurements based on space-based ADS-B aircraft trajectories: While data must be collected from many different sources to provide intelligence about the leading factors to today's top accident categories, these metrics from ADS-B trajectories can be used to inform safety professionals and key stakeholders on performance related to mid-air collisions, approach and landing risks and runway surface safety risks. Monitoring key metrics as Safety Performance Indicators (SPIs) can help supplement safety knowledge to safety professionals whose organizations already have either robust or sparse data collection capabilities.

#### **4. LAGGING AND LEADING INDICATORS ENABLED BY SPACE-BASED ADS-B**

4.1 ICAO defines safety performance indicator as a data-driven safety measure used to monitor and assess the performance of the system over a given period of time. These measures can be used to help achieve performance targets as the planned or intended objective for safety performance. Risk management focuses on improving the known risk areas through deeper understanding of the potential factors that can lead to an accident. As the relationship between these factors becomes understood, monitoring of these risk factors through SPIs can provide critical information that might help both from a predictive and reactive perspective.

4.2 SPIs, which can be compared to a business Key Performance Indicator (KPI), are often classified into two general categories: (a) lagging indicators and (b) leading indicators. Lagging indicators measure the outcomes whereas leading indicators often focus on the strength or the health of a system. The combination of both lagging and leading indicators is generally viewed as providing the best information on improving risk.

4.3 Lagging Indicators measure safety events that have already occurred including those undesired safety events organizations aim to avoid. Lagging indicators can be lower level system failures, an undesired aircraft state, an aircraft incident or aircraft accident. Some of the lower level failures or undesired aircraft states can be thought of as “precursors” to bad outcomes that lead to aircraft incident and accidents. Because they are safety outcomes, they are often used to assess the effectiveness of operational safety. Space-based ADS-B data can help to produce many types of lagging indicators.

4.4 Leading indicators provide information on the current system or operations that may affect future performance. Leading indicators can measure issues that have the potential to become or contribute either positively or negatively to future safety outcomes (positive/negative indicators). Leading indicators may also be used to inform decision-makers about the dynamics of the operational system and how it copes with any changes, including changes in technology and the operating environment. These indicators can focus on either (a) anticipating emerging weaknesses and vulnerabilities to determine the need for action, or (b) monitoring the extent to which certain activities required for safety are being performed. Space-based ADS-B derived SPIs can enable both these two monitoring requirements.

4.5 Safety performance measurement should ideally consider a combination of leading and lagging indicators. The main focus should be to measure and to act upon the presence of those systemic and operational attributes that enable effective safety management within an organization and meanwhile, use lagging indicators to ensure that this safety management is effective. Lagging indicators, particularly indicators for lower level system failures, are useful to validate the effectiveness of specific safety actions and risk barriers or to support the analysis of information derived from your leading indicators.

4.6 The following are examples of operational safety performance measurements (lagging and leading) that could be enabled globally using space-based ADS-B.

4.6.1 Approach and landing operations

4.6.1.1 The missed approach is a measure of an aborted landing with potential causal factors of the event. It is possible to determine whether the aircraft’s energy state, other traffic, weather, or wind were a causal factor of the event.

4.6.1.2 The overshoot of final approach is a measure of the aircraft path as it acquires the runway's extended center line. The metric measures the angle of intercept, height above glideslope at intercept, ground speed at intercept, and the resulting overshoot, if any.

4.6.1.3 The high-energy state of aircraft is the physical components the aircraft's energy state (ground speed, altitude, and decent rate) as well as other contextual data including separation of other aircraft, airport demand, and weather.

4.6.1.4 Similar aircraft call signs can be a human-factors issue when clearances are issued. The ability to automatically identify the interaction for aircraft call signs that are either similar sounding or similar looking and how often they occur are useful for awareness purposes.

4.6.1.5 Airspace infringement is when an aircraft enters notified airspace without previously requesting and obtaining clearance from the controlling authority of that airspace, or enters the airspace under conditions that were not contained in the clearance. This applies to approach and landing and all other phases of flight.

4.6.1.6 Converging runway operations are where flight paths of two aircraft intersect (but extended runway centerlines do not) showing potential for departure/go-around loss of separation.

#### 4.6.2 Surface Operations

4.6.2.1 Risk of runway overrun measures the amount of runway remaining during aircraft deceleration after touchdown - aircraft speed and runway parameters can be set (e.g. less than 1200 feet runway remaining at 50 knots) to identify operations with high excursion risk.

#### 4.6.3 Departure operations

4.6.3.1 Rejected takeoff measures aborted takeoffs, where adequate space-based ADS-B coverage exists for surface aircraft movement.

#### 4.6.4 En-route operations

4.6.4.1 Loss of separation measure of separation between two aircraft, closure rates, time to conflict and risk of collision.

4.6.4.2 Restricted airspace excursion identifies instances and locations where aircraft penetrate specified restricted airspace.

4.6.4.3 Risk of collision with terrain identifies instances and locations where aircraft penetrates minimum safe altitudes established to separate aircraft from terrain.

4.6.4.4 Occurrences of turbulence derived from ADS-B data using various algorithms.

4.6.4.5 As new procedures, such as RNAV or RNP, are developed and utilized, safety can be validated through conformance monitoring of the intended flight track. This can provide verifiable altitude and directional results in various conditions including convective weather.

#### 4.6.5 Aerodrome and Airspace contextual information

4.6.5.1 Aerodrome: A daily operational overview can be developed to provide the safety council(s) with a consolidated view of pertinent operational information. Providing this information in an integrated and easily accessible fashion enhances the understanding of the context in which an incident may have occurred. This information is compiled and presented for day-after analysis.

#### 4.6.6 Aerodrome Contextual Information

4.6.6.1 A multitude of aerodrome contextual information including meteorological surface observation reports, Digital Automatic Terminal Information Service (DATIS), traffic flow management system information, pilot reports (PIREPS), and convective weather information, surface contamination information, runway configuration, arrival and departure procedures, pilot reports. Additionally, operational information such as traffic holds and diversions, timeline of the various traffic management initiatives implemented within the aerodrome airspace.

#### 4.6.7 En-Route Airspace Contextual Information

4.6.7.1 The en-route airspace information provides a high-level overview from the perspective of an air navigation services provider (ANSP), including sector traffic flows, sector volume, traffic flow information, and meteorological specific data.

### 5. **TYPES OF ANALYSIS ENABLED BY SPACE-BASED ADS-B**

5.1 There are several types of analysis that can be carried out using a variety of data sources, including space-based ADS-B data. Several initiatives in different regions have developed significant capabilities, including the U. S. Commercial Aviation Safety Team (CAST) and Aviation Safety Information Analysis and Sharing (ASIAS), EASA Data4Safety (D4S), the Asia Pacific Regional Data Collection, Analysis and Information Sharing for Aviation Safety (AP-Share) Demonstration Project, ICAO Regional Aviation Safety Groups (RASGs) and IATA's FDX program supporting several regional data sharing activities. No matter how extensive the data analytics have become, space-based ADS-B data can complement these initiatives by better describing the outcomes and the potential causes. Even though ideally ADS-B data is best combined with other data sets for greater validation of safety issues, there is some analysis that can be performed entirely on ADS-B data alone.

5.1.1 Benchmarking: Airlines and other service providers often are interested in how their performance compares to the broader industry. Constructing a range of performance overlaid with an individual stakeholder provides a benchmark capability for the individual participant stakeholders to assess their performance against an appropriate aggregate cohort group (e.g. airlines, ANSPs, aerodromes). Benchmarks can be used to prioritize an individual entities safety initiatives. A wide range of benchmarks for participants can be established and be routinely monitored. Benchmarks can be generated, quality checked, de-identified, and posted for participants. The utility of the information provided for benchmarks increases with larger space-based ADS-B trajectory archive sets, enabling more robust statistical analysis. Participants will be able to routinely use the benchmarks and trending metrics to perform safety assessments, proactively identify problems, and initiate remedial action as part of their SMS activities.

5.1.2 Safety Enhancement Monitoring and Assessment: Once implementation of a new enhancement is underway space-based ADS-B SPIs will enable monitoring the progress of safety mitigations (e.g. as part of SSP), either in combination with other data sets or, when appropriate, on a stand-alone basis. These SPIs can be analyzed over time as the implementation levels grow to determine the enhancement effectiveness. SSP managers can view this over regular intervals during the implementation. As part of SSP, safety organizations can expand the breadth of studies and metrics development as new vulnerabilities emerge via expanded capabilities.

5.2 In-depth studies: As part of the SMS process, there may be instances where understanding of safety hazards and risks are challenging, and the effective mitigations may not be straightforward or obvious. In these cases, in-depth analysis with an expanded data set and more extensive reliance on subject matter expertise (SMEs) may be necessary. Space-based ADS-B data may offer a highly effective option during these in-depth studies, as a stand-alone source or as a supplement to the organization's existing organic data.

5.3 Monitoring of known risks: In the course of implementing an SMS within an organization and through hazards and risks need to be routinely identified. Some of these risks and hazards may have been previously identified through the course of an accident or incident investigation. It is desirable to objectively track and monitor these risks over time. Space-based ADS-B SPIs can be developed to achieve this objective for certain risks within an organization.

5.4 Discovering unknown risks: The aviation system is complex and dynamic and is in a constant state of evolution, as new technologies, capabilities, procedures, processes and systems are introduced. Therefore, the nature of risks and hazards are also dynamic and change over time. While some risks are well understood and can be measured and mitigated through the application of SMS, there may be previously unknown issues or accident precursors that can only be discovered through special data mining techniques. The mining of large sets of space-based ADS-B data, combined with other data sets can enable the discovery of unknown risks.

## **6. LIMITATIONS OF SPACE-BASED ADS-B DATA**

6.1 While space-based ADS-B do provide highly accurate trajectory information and can capture special safety events from aircraft track history (such as TCAS RAs), there are limitations to the usefulness of this data for certain types of safety analysis. For example, aircraft trajectory information, while highly accurate, will not be able to provide any insights into important flight information such as flap settings, roll and pitch parameters, aircraft weight, and many other aircraft sensor tracked data captured from flight data monitoring (FDM) data sources. For certain safety issues, FDM data is required to fully understand the risks and develop effective safety mitigations. In addition to digital data that illustrates "what happened", safety reports, in the form of text reports by crew or mechanics, describe in more detail the circumstances around a safety incident and can help explain "why it happened". Space-based ADS-B trajectory information will not be able to serve as a substitute for these other important data sources and, therefore, when used as a sole source of data in generating SPIs, the analysis must be accompanied with appropriate caveats and limitations on conclusions or assertions.

## **7. POTENTIAL USE OF SPACE-BASED ADS-B BY DIFFERENT SECTORS, SERVICE PROVIDERS AND DATA SHARING PROGRAMS**

### **7.1 Commercial air transport providers**

7.1.1 ICAO Annex 6, for commercial air transport, requires States to establish a safety programme in order to achieve an acceptable level of safety in the operation of aircraft. As part of their safety programme, States require operators to implement an accepted safety management system (SMS). The SMS for commercial operators requires establishment of safety analysis capabilities, including Operational Flight Data Monitoring (OFDM) which in North America has become known as Flight Operations Quality Assurance (FOQA). It is a process which routinely captures and analyses flight recorder data in order to improve the safety of flight operations. This operational analysis is often viewed as a proactive use of recorded flight data from routine operations to prevent incidents and accidents. FDM programs, for those aircraft that are appropriately equipped, are increasingly useful in understanding the “what happened” and often useful in developing mitigations. However, not all aircraft in the worldwide fleet are equipped with FDM recorders. Many aircraft are below the minimum gross weight requirements Annex 6 or operating in countries where the Annex 6 requirements are not mandated. Therefore, only a portion of the industry produces useful FDM data for SMS risk management purposes. Space-based ADS-B data is ubiquitous, since there will be universal requirement for aircraft to be equipped with ADS-B out capability by 2020. Therefore, there will be global coverage of all aircraft operations. This provides the ability to conduct a comprehensive set of analyses of all aircraft operating in the system, and not only understand events from a single aircraft perspective, as in the case of individual FDM programs, but also from interactions between aircraft.

### **7.2 Business aircraft operations**

7.2.1 Since most business operations FDM programs are voluntary, the percentage of aircraft equipped and covered under an operational FDM program is far less than the commercial airline fleet. Many operators may have only 1 or 2 aircraft in the fleet and the cost benefit ratio has not been satisfied for FDM program implementation. To an even greater degree than commercial operations, the ADS-B data will allow for data analytics on business and charter operations where FDM programs have been non-existent.

### **7.3 Aerodrome service providers**

7.3.1 A system risk assessment utilizing appropriate data sources allow aerodrome operators to develop an objective assessment of the risk involved in airside operations. A number of data sources are available to aerodrome operators, including audits, safety reports, data from regulators or ANSPs. Some Aerodrome operators have sophisticated data collection and analysis capabilities. However, in general, there is a limited number of data sources available to aerodrome for independent risk analysis on their respective airside operations. Space-based ADS-B safety derived insights can serve as a supplemental source to aerodromes operators to facilitate risk analysis and mitigations. For example, surface safety which continues to be a concern in many regions around the world, can be further illuminated by leveraging surface ADS-B data where available.

## 7.4 Air Navigation Service Providers

7.4.1 Across the air traffic community, ANSPs are at different levels of SMS development and implementation. Some service providers have very mature systems, leveraging extensive data sources for hazard identification, mitigation and monitoring. Other service providers are still in the early stages of SMS implementation, often with access to high quality safety information. This diversity can be attributed to the existing differences in national regulatory frameworks and (un)availability of sources of data resources at local levels. To advance ANSP safety goals, a number of activities are recommended and encouraged:

- a) develop and implements common definitions through fostering global harmonization on SPIs;
- b) develop predictive measures of risk and positive safety performance metrics;
- c) create new leading indicators so that each ANSP can better understand their safety performance and risk control effectiveness;
- d) conduct analysis based on comprehensive data mining, statistical research and in depth comparison to improve operational safety;
- e) periodic reports to help with better understanding of the ATM system's current safety status and awareness about trends in potential safety hazards;
- f) explore the development of alternative measures of safety that better reflect accident risk; and
- g) investigates the use of data from the operation to proactive identify risks.

7.4.2 These goals can be effectively supported through leveraging space-based ADS-B derived SPIs.

## 7.5 Regulators

7.5.1 ICAO Annex 19 lays forth requirements for States to establish both mandatory and voluntary incident reporting systems. Annex 19 also recommends that States establish other safety data collection and processing systems that might not be captured in the incident reporting systems. Along with the incident reporting systems regulators are conducting their own surveillance (audits, inspections and monitoring activities) to assure acceptable levels of safety. SPIs derived by space-based ADS-B flight trajectory information can serve to supplement the regulator's data needs by providing exposure to conditions that might not be captured in the incident reporting, surveillance or other data collection systems. In addition, investigators are often determining recommendations for improving operations based on findings from an aircraft accident and may need to understand the conditions present in routine operations in order to prioritize their recommendations.

## 7.6 Data sharing programs

7.6.1 There are several national and regional data sharing programs that leverage a variety of data sources to develop SPIs and safety insights. These data sharing programs include the U.S. CAST and ASIAs, EASA Data4Safety, the AP-Share Demonstration Project, and Regional Aviation Safety Groups (RASGs), who are engaged in data sharing activities. Most of these programs leverage voluntary safety reports, Flight Data Monitoring (FDM) data, radar surveillance data, and other contextual information. In some cases, like AP-Share as an example, programs may utilize a limited set of ground-based ADS-B data sources to develop safety insights. The depth and breadth of data collected and analyzed across these data sharing programs varies greatly. Some States may never be able to achieve the level of investment to utilize the most comprehensive data sources that some States have achieved. Space-based ADS-B trajectory information can serve as a useful supplemental information for many States.

## 8. **DEVELOPMENT OF PROPER GOVERNANCE FOR USE OF SPACE-BASED ADS-B DATA IN DEVELOPING SPI AND SAFETY INSIGHTS**

### 8.1 Background

8.1.1 Historically, ICAO has established Standards and Recommended Practices (SARPs) requiring States to establish safety data or reporting systems contained in several key Annexes and documents. Most of these requirements are sector-specific except those in Annex 13 — *Aircraft Accident and Incident Investigation*, which covers accidents and serious incidents for the entire industry. So, while the safety improvements and recommendations from accidents and incidents are generally public information for the world to use to improve safety the safety data collection systems still only apply to the largest operations.

8.1.2 Based on ICAO Annexes and Guidance, operators, service providers and States have developed successful safety reporting programs. Many collect a wealth of safety data and safety information in their respective SMS programs from both voluntary reporting and automated data capture systems.

8.1.3 ICAO has stressed the importance of a just-culture and non-punitive approach to safety data collection, comprehensively captured in several Annexes and documents. ICAO has also stressed the importance of safety data collection as part of implementing SMS and SSPs, with the main purpose to achieve effective risk management through good data and analytic efforts so that reducing risks can prevent accidents or incidents. Yet, the use of data gathered for SMS safety information to conduct enforcement penalties will most likely result in a “chilling effect” on the flow of voluntary safety information that is critical to understanding the relationship of all risk factors in the SMS process. Therefore, ICAO and other safety organizations have advised against the misuse of this type of safety information. ICAO has routinely supported the value of the protecting safety information through proper aggregation and de-identification of operators, service providers or employees.

## 8.2 Proper use and application of space-based ADS-B data

8.2.1 Historically digital flight information was not readily available or accessible. However, with the advent of ADS-B, highly accurate flight path information is now ubiquitous and available through commercial sources. The ADS-B flight path information contains flight number, tail number and specific dates and times of the flight. While there are numerous applications and benefits of using space-based ADS-B data to develop important safety insights, there is growing concern that this type of information can be misapplied or misused and degrade years of advances in safety systems and programs.

8.2.2 The Flight Safety Foundation (FSF) has initiated an activity to develop a governance process for leveraging space-based ADS-B flight information in the development of SPIs and safety insights within the SMS framework, as described in this paper. As part of the governance process, data protection guidance and best practices will be developed. FSF is currently engaging stakeholders from around the world to participate in developing guidelines and processes to ensure the SPIs and safety insights:

- a) are harmonized and consistent with on-going efforts;
- b) the ADS-B data is properly de-identified and aggregated;
- c) the derivative data, results and analyses, when fused with other data sources, are properly de-identified and aggregated;
- d) secure processes for timely sharing of SPIs and safety insights are developed;
- e) analyses are conducted in accordance with guidelines that govern de-identification protocols and access to sensitive data;
- f) define roles and responsibilities for stakeholders and users of SPIs;
- g) data are used only for safety analysis, and not for punitive actions against individuals or organizations; and
- h) data are properly de-identified and aggregated to protect individuals and organizations.

## 9. CONCLUSIONS

9.1 Space-based ADS-B is rapidly gaining momentum as a sole source or complementary source of surveillance for air traffic separation with global coverage. Real time safety information via space-based ADS-B can be extracted to improve overall safety of operations.

9.2 Space-based ADS-B will be able to generate highly accurate trajectory information that can be archived for data mining and analysis. In addition to accurate flight tracks, space-based ADS-B can help manage risk information for several accident categories beyond mid-air collisions.

9.3 Effective SPIs can be derived from flight trajectory data, which when combined and fused with other data sources and contextual information, can provide new and valuable safety insights.

9.4 These SPIs can benefit many stakeholders including regulators, ANSPs, aerodrome operators, commercial and business operators. In addition, space-based ADS-B generated SPIs can support regional data sharing initiatives, either as stand-alone or in conjunction with other data sources.

9.5 Producing these SPIs using commercial ADS-B vendors will require resources, as the provision of the data and the analytical work is not free. However, with a broad-base use of these SPIs across many stakeholders, the marginal cost to each user becomes manageable.

9.6 Proper use of ADS-B data in generating SPIs as part the overall goal of improving safety is critical. De-identification of the data and proper protection of the data following ICAO safety information principals are necessary for continued improvement and maturity in both SMS and SSPs.

## 10. **NEXT STEPS**

10.1 A governance process will be established to engage a broad spectrum of the international stakeholder community to assist with the development of guidance, protocols and harmonized methods to develop SPIs and safety insights using space-based ADS-B data, in conjunction with other data sources.

10.2 The Flight Safety Foundation has begun a process of forming a governance group and process and is soliciting contributors and participants from the international community.

10.3 It is anticipated that in 2020, an initial governance process and an initial set of SPIs will be available for use by stakeholders.

## 11. **RECOMMENDATIONS**

11.1 The Assembly is invited to:

- a) note the potential benefits of space-based ADS-B data in the development of SPIs and safety insights; and
- b) encourage States and Industry to support the Flight Safety Foundation in the formation of a collaborative governance process and the development of SPIs and safety insights to achieve the GASP safety goals.