SESAR DEPLOYMENT MANAGER

# ADS-B Implementation Programme and Status Report (2020 release)

Deliverable 5.2.2.1

# Control

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| **Approved by** | **Nicolas Warinsko**<br>General Manager | **Date**<br>16/12/2020 | **Signature**<br>Signed |
| **Reviewed by** | **Mariagrazia La Piscopia**<br>Chief of Strategy and Programme Management | **Date**<br>15/12/2020 | **Signature**<br>Signed |
| **Prepared by** | **Jan Stibor**<br>ADS-B Implementation Programme Manager<br><br>**Cristian Pradera**<br>Manager Deployment Programme and Planning<br><br>**Johan Martensonn**<br>Surveillance Expert (EUROCONTROL) | **Date**<br>14/12/2020 | **Signature**<br>Signed |

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# 1. Introduction

Commission Implementing Regulation (EU) No 1207/2011 ("the Regulation") lays down the requirements on the systems contributing to the provision of surveillance data, their constituents and associated procedures, in order to ensure the harmonisation of performance, the interoperability and the efficiency of these systems within the European Air Traffic Management Network (EATMN) and for the purpose of civil-military coordination.

In order to foster deployment and promote implementation of ADS-B in both airborne and ground domains, the European Commission appointed SESAR Deployment Manager in July 2018 to develop with the stakeholders a consolidated "ADS-B Implementation Plan" focussed on achieving the best possible compliance with the 2020 deadline. SDM produced, consulted and submitted the coordinated Implementation Plan on 18th December 2018 and as of January 2019, the plan went into its execution phase.

This document presents the Edition 2020 update of the ADS-B Implementation Plan, and is the first update following the passage of the first regulatory deadline[1] of the SPI IR, 7th December 2020. It was elaborated with support from EUROCONTROL on matters covering avionic equipage monitoring and general operational and technical coordination. Apart from the periodic update on the progress of implementations in both domains, this edition puts particular emphasis on the following new aspects which SDM considers to be of prime importance:

- The impact and effect of the most recent update of the Regulation, by way of CIR 2020/587[2], which inter alia formalized a transition regime which was anticipated in the previous editions of this Implementation Plan,
- The effect of the ongoing COVID-19 related crisis in the aviation industry on the progress of ADS-B implementation efforts in Europe,
- An exploration of ADS-B deployments and benefits realized at airport level, prepared with the support of SESAR-related Deployment Airport Grouping (SDAG) of ACI Europe.

The ADS-B Implementation Plan has no legal implications; however, it complements the existing regulation and, as a consequence, it can be considered as supporting material by the involved stakeholders.

[1] As of 7th December 2020, a forward fit of ADS-B Out is required.

[2] Note that the original regulation CIR(EU) n. 1207/2011 was amended three times in total, successively by CIRs (EU) nos 1028/2014, 2017/386 and 2020/587.

# 2. Status of SPI IR Implementation in the Airborne Domain

This chapter details the overall airborne implementation plan and its progress; all figures presented in this chapter are referenced to 1st November 2020, unless stated otherwise.

## 2.1. Evolution of ADS-B V2 equipage

This section provides a comparison between aircraft operators' ADS-B Version 2 implementation plans and the actual monitored equipage rates.

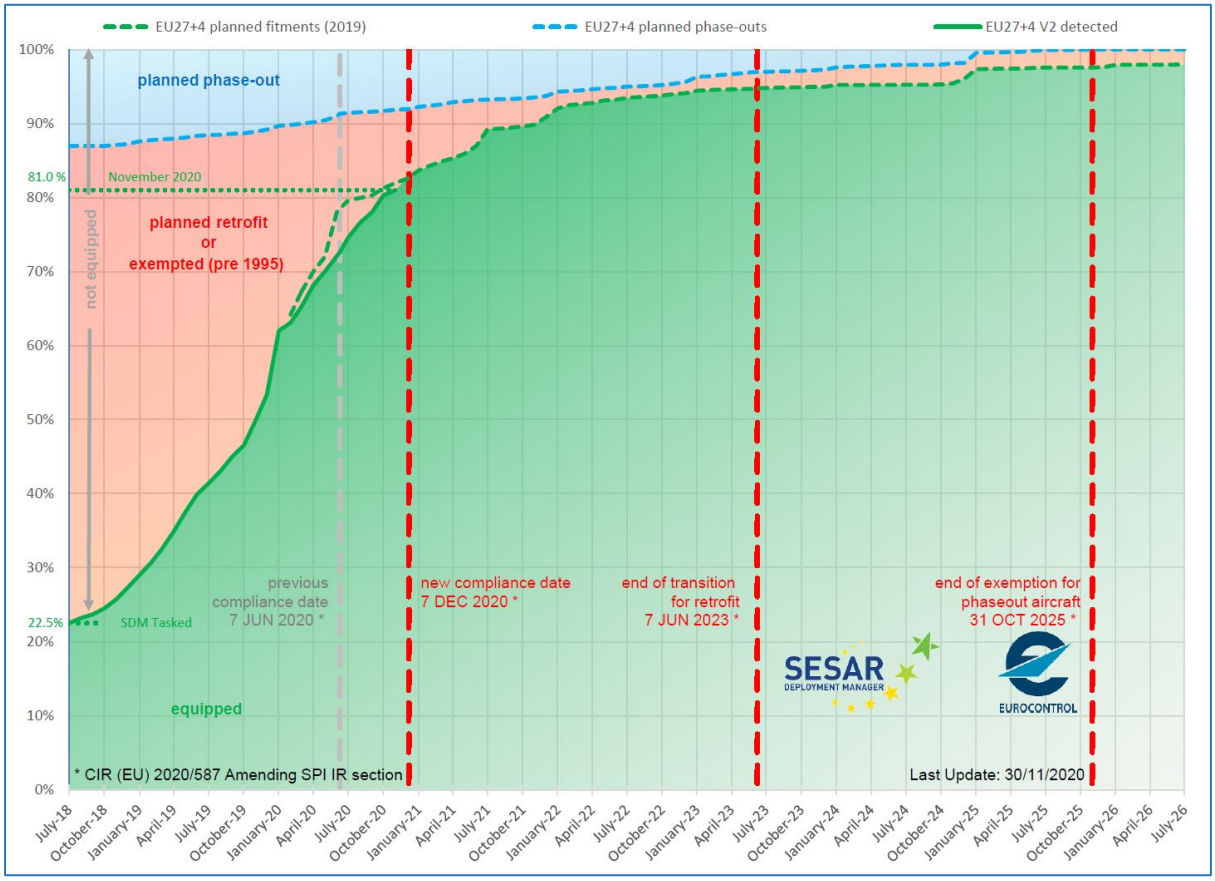


**Figure 1 Updated AU implementation plans and monitored equipage of SPI IR mandated EU27+4 registered fleet[3]**

The green area, tagged "equipped", represents the proportion of the EU27+4 based, mandated fleet that is equipped with ADS-B V2. The area is bounded by the ratio of airframes detected broadcasting ADS-B V2 (solid green, source: EUROCONTROL) and consolidated operator fitment plans (dashed green).

The red area represents the proportion of the fleet not equipped with ADS-B V2 and:

- either subject to the following provisions of CIR 2020/587, Art 5:
  - *Operators of aircraft with a first certificate of airworthiness issued before 7 December 2020 shall comply by 7 June 2023 with the requirements set out in points (b) and (c) of the first subparagraph, subject to the following conditions:*
    - *(i) they have established before 7 December 2020 a retrofit programme demonstrating compliance with points (b) and (c) of the first subparagraph;*

[3] The diagram in Figure 1 presents the status of airborne implementation as of 1st November 2020.

- *(ii) those aircraft have not benefitted from any Union funding granted to bring such aircraft in compliance with the requirements set out in points (b) and (c) of the first subparagraph.*

- or not required to fit by virtue of having their first individual Certificate of Airworthiness pre-dating 7 June 1995. This particular population constitutes the sole occupants of the red area in the diagram following 7 June 2023.

The blue area represents the fleet with no ADS-B version 2 fitment plans and which is intended to be phased-out prior to 31 October 2025 as per the respective provision of CIR 2020/587 Art 5.

The red and blue areas are delineated by consolidated operator phase-out plans (dashed blue). As operator fleet planning is subject to change, some migration of airframes between the red and the blue areas is expected to occur.

In Chapter 0 we explore in detail the effect of the most recent SPI IR amendment - CIR 2020/587, and the impact of the COVID-19 crisis.

SDM has coordinated the consolidated implementation plan with IATA, A4E, AIRE, EBAA, ERA, and directly with some of the major European carriers through bilateral meetings.

***Analysis:***

The monitored equipage ratio (solid green in Figure 1 above, source: EUROCONTROL) is calculated each month based on the number of active aircraft, where active refers to aircraft that have operated in Europe during the recent 6 months. Equipped aircraft are those that were detected to transmit ADS-B Version 2 (per EUROCAE ED-102A4) which is required by the SPI IR. As of October 2020, the monitored equipage ratio has reached 80.3%, including airframes older than June 1995 that are not required to fit as per CIR 2020/5875, and is slightly behind the planned data point at 81.3% as provided by the air operators. For reference, the equipage ratio stood at 22.5% in July 2018 when SDM was mandated by the European Commission to initiate the ADS-B programme. At end of September 2019 (2nd annual edition of this report) the value stood at 46.5%. Therefore, the overall increase of the equipage rate since the ADS-B programme commenced was approximately 60%.

*Note: The equipage rate of the global fleet, as opposed to EU27+4, is monitored to be slightly ahead[6]. In October 2020, EUROCONTROL monitored 87.5%[7] of the airframes operating GAT IFR flights in NM area transmitting ADS-B V2 compared to 80.3% of reference fleet per Figure 1. For reference, in October 2019 the compliant rates had been 58.8% overall and 46.5% for the reference fleet.*

[4] ED-102B / DO-260C defining ADS-B Version 3 is expected to be released in near future. V3 is not a mandated ADS-B variant.
[5] According to EUROCONTROL, the equipage rate stands at 83.9% if the pre-1995 fleet is disregarded.
[6] Higher share of Long Range equipment subject to other mandates at TCOs
[7] Per EUROCONTROL website https://www.eurocontrol.int/service/adsb-equipage

## 2.2. Impact of CIR 2020/587 and COVID-19 on fleet fitment planning

In summer 2020, SDM started a survey asking airlines for planning changes in ADS-B fitment after the release of the SPI IR amendment (CIR 2020/587) and in the light of the COVID-19 crisis in the aviation industry.

By mid-October, 17 air operators responded, representing 2291 airframes planned in operation per 31 December 2020, which covers about 50% of the fleet represented in Figure 1.


**Figure 2 - 2019 vs. 2020 Survey**

Dashed lines in Figure 2 show the results of the 2020 survey compared with 2019 data. The bars, referenced to the secondary vertical axis on the right, show the number of airframes that contributed to the data base of each survey. Despite the more flexible exemption and transition regime after the SPI IR amendment in April 2020, the ADS-B version 2 fitment planning is slightly ahead of the outcome of the 2018/2019 surveys with some uncertainty due to the fact that the reports only cover 50% of the 2019 fleet and the majority comes from the larger airlines with fleets of more than 50 aircraft. Furthermore, the ever evolving nature of the ongoing COVID-19 crisis further compounds the instability of the plans as operators are continuously forced to adjust their fleet management strategies in response to the travel restrictions imposed by states and the fluctuations in travel demand. 35% of the reporting airlines indicated that the planning at the time of reporting could not be considered as stable as a result of the unpredictable evolution of the COVID-19 crisis.

Notwithstanding, the behaviours of the green and blue trend lines in Figure 2 are very similar. SDM therefore concludes that **while there was some discernible impact of both the SPI IR Amendment CIR 2020/587 and the ongoing COVID-19 crisis in the aviation sector, the airspace user segment remains committed to meeting the objective of SPI IR. However, since the COVID crisis is far from resolved at the time of writing of this chapter, a concrete need persists to continue to monitor and assess the evolving impact.**

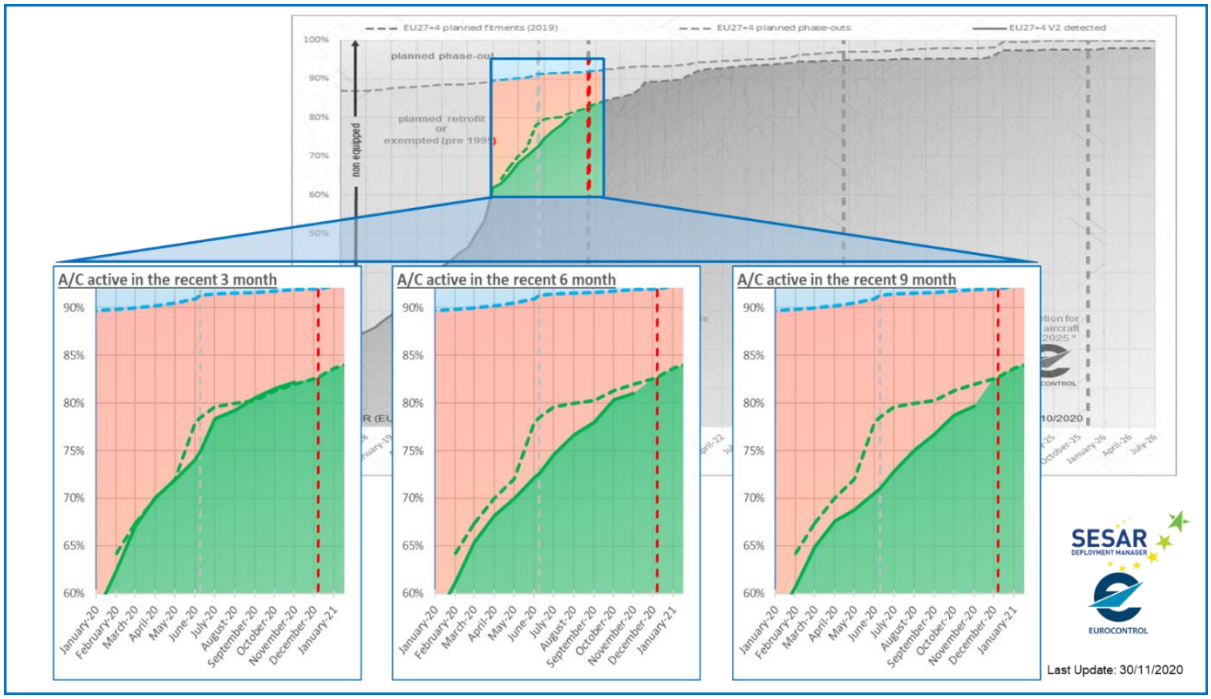


**Figure 3 - Sliding window for active airframes**

To further explore in details this uncertainty in operator fitment plans, SDM and EUROCONTROL analysed the near term behaviour of the equipage evolution curve from Figure 1, by varying the basis of the data; that is, the size of the window which defines active aircraft, whose detection contributes to the formation of the solid green line.

An active aircraft is defined as such that operated at least one GAT/IFR flight in the six month prior to the date of the related data point, meaning that the data point for September 2020 reflects all aircraft detected between March and September. The nominal monitored equipage rate for October 2020 is detected with 80.3%.

In Figure 3, the default window size of 6 months is reproduced from Figure 1 and is flanked by two adaptations. In the left pane, the window is shortened to three months, so as to encompass only the most recently appearing aircraft. The relative equipage rate is 81.5%[8]. In the right pane the longest lookup window is used at 9 months, corresponding to with 78.7%[9].

The spread of default +/-3 months results in a variance of 2.8 percentage points.

On the basis of the above, SDM estimates that the intercept value of equipage ratio on the day of entry into force of the forward-fit mandate, 7 December 2020, based on the 6-month window method, will be at 84.5%.

[8] Here a corresponding assumption is made that the aircraft not detected by the monitoring activity, will not return to operations in SES airspace post-COVID.
[9] Here a corresponding assumption is made that the aircraft not detected by the monitoring activity are in temporary storage and will return to operations in SES airspace post-COVID.

## 2.3. About our data

This coordinated ADS-B Implementation Plan is based on individual operator plans to equip in accordance with the Regulation. The operators have submitted their plans and updates to SDM as part of regular surveys since spring 2018. At the time of writing, this plan is based on data from 90 air operators based in EU27+4 states, covering 4560 airframes, out of which 2291 have been refreshed in the 2020 survey campaign. It is estimated that this sample is representative of 60% of the entire mandated population based in EU27+4 and EUROCONTROL estimates that this sample generates 85% of IFR movements in EU airspace performed by EU27+4 registered airplanes.

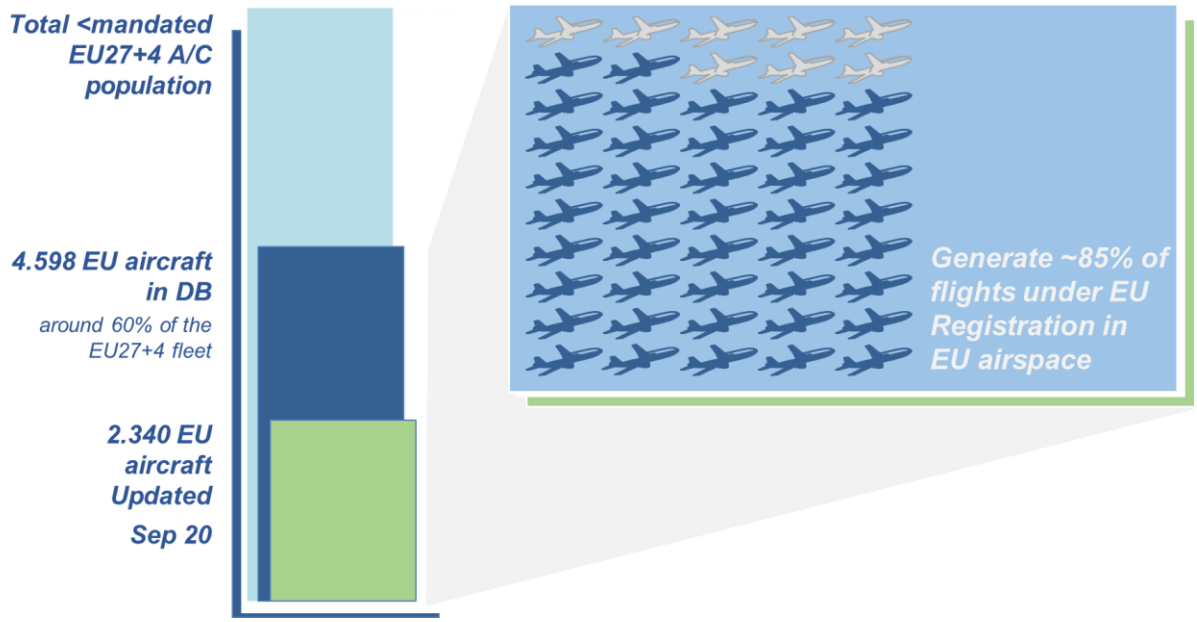


**Figure 4 SDM database of AU planning data**

Progress in accordance with the plan is monitored primarily through EUROCONTROL airborne monitoring activity and reported to SDM at monthly intervals. EUROCONTROL monitor ADS-B data broadcast by aircraft transponders, including DO260B/ED102A ("ADS-B Version 2") compliant transponders; it is then assumed that a transponder broadcasting Version 2 is representative of an on-board installation compliant with the ADS-B part of the SPI Regulation[10].

The remaining unknown 40% of EU registered airframes are operated in fleets with relatively few (<10) aircraft and therefore difficult to reach by the surveys; however, we assume that the behaviours of both populations are sufficiently similar.

[10] In addition to the ED102A compliant transponder, EASA CS.ACNS stipulates requirements on data items, data sources including the position source, airframe installation, flightdeck interface, system performance and data parameters.

## 2.4. Equipage by aircraft age

This section explores the relationship between equipage rate and the build year of aircraft.

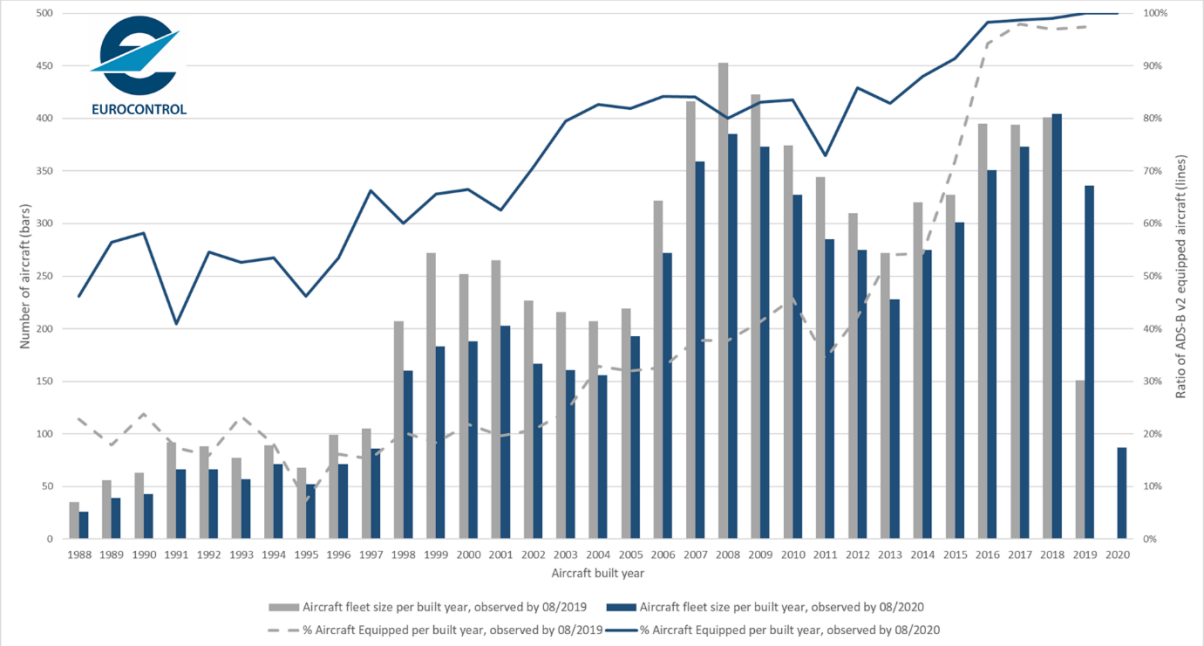


**Figure 5 ADS-B Version 2 Equipage rate by aircraft built year**

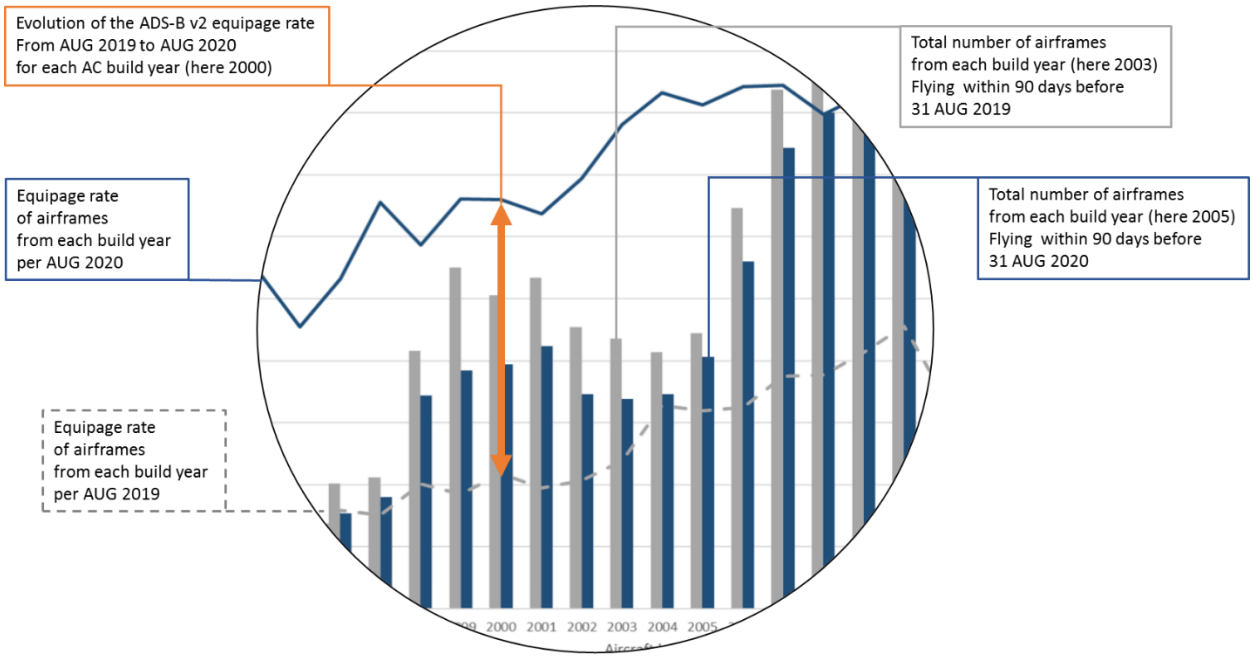


**Figure 6 Guidance to Figure 5**

***Analysis:***

In Figure 5, the area bounded by the two trendlines represents the equipage increase achieved by retrofit installations, during the one-year time period from August 2019 to August 2020. The spread reaches an extent of over 40 percentage points approximately between build years 1998 and 2014 and remains significantly stable. This reflects the intensive retrofit effort expended by air operators between summer 2019 and summer 2020. Concerning the shallowing of the retrofit rate which is

visible from build year 2015 and onwards, SDM assumes that these build years have anticipated the upcoming mandate and consequently were already delivered with the required functionality installed.

The shrinkage of the active EU fleet is apparent from the disparity of the 2019 sample (grey bars) and 2020 sample (blue bars). As the samples are taken in three summer months of both years, it is logical to conclude that we are seeing the effect of the COVID-19 crisis in full swing in 2020. The only year that appears unscathed is the build year 2018, and the most recent year to be fully representative in the data sample. This would point to a hypothesis that aircraft built in 2018 were most likely to remain operational throughout the pandemic. There does not appear to be any particular trend in the years 1988-2017, rather the difference seems to fluctuate around a central point. SDM believes that if data for 2019, 2020 was complete, a similar trend to 2018 would be observed, i.e. newest aircraft seeing highest utilization rates.

The fleet which is subject to the indefinite exemption due aircraft age (pre-1995 fleet) achieved a remarkable increase in equipage, from approximately 18% in 2019, to the vicinity of 50% in 2020. SDM hypothesizes that high-longevity aircraft which are anticipated to remain operational beyond 2025, may be driven towards fitment by other mandates, or may have been already fitted in anticipation of the then-upcoming mandate.

## 2.5. ADS-B Version 2 Flights Equipage Density Map

The Equipage Density Maps in Figure 7 (data source: EUROCONTROL) visualise the evolution of the relative proportion of ADS-B Version 2 equipped flights over ECAC area. The map is generated using aircraft equipage information combined with flight data. The flight data includes traffic known to the EUROCONTROL Network Manager, meaning flights operating within, or incoming to, or exiting out of the NM area. Consequently, local traffic operating outside the NM area and thus not relevant to European regulation, is not included. Each cell of each map shows the proportion of flights equipped with ADS-B version 2 in relation to the total number of flights known to NM in that cell. The equipage ratio is expressed with colours and a colour legend is located on the right-hand side of the maps. Empty (white) cells signify insufficient data sample.

In the first snapshot from March 2018, red and orange, representing equipage rates around 25% are dominating. The equipage rate evolves and by September 2020 the dominant colour is green representing about 80% ADS-B version 2 equipage rate with yellow areas where lower rates are observed.

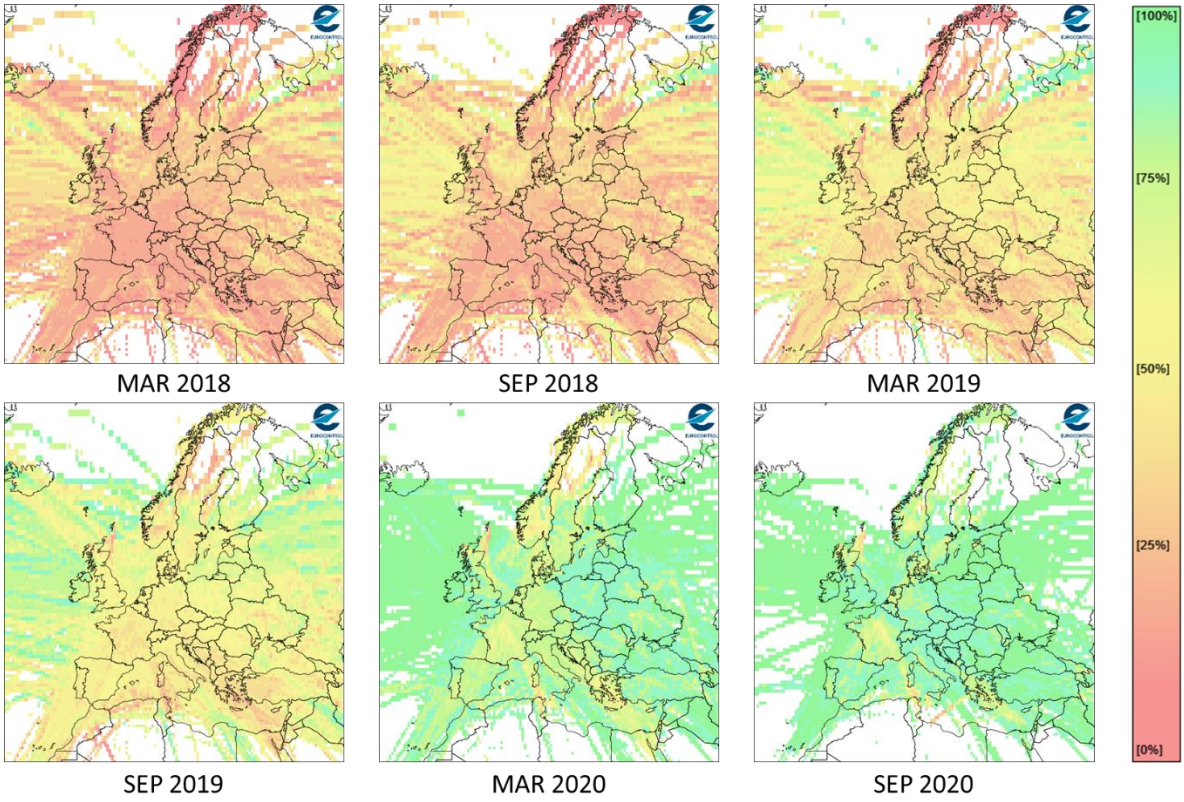


**Figure 7 Evolution of ADS-B Version 2 Flights Equipage Density**

Comparing the equipage density map from September 2018 in Figure 7, with the map from September 2019 we can observe that flight-based equipage rates have grown with about 25 percentage points in this period. In the period from September 2019 to September 2020 the corresponding increase was roughly 30 percentage points.

It can also be observed that there is a significant difference in the level of equipage between areas where mainly long-haul aircraft are operated (e.g. North Atlantic) compared to areas where mainly short-haul aircraft are operated.

## 2.6. Stakeholder concerns regarding aircraft privacy

In response to recurrent concerns raised by airspace users, mainly business jet operators, SDM explored in detail the matter of operator privacy as relating to ADS-B. The Regulation requires aircraft operators to broadcast information which makes it possible to establish and monitor the location of any specific individual aircraft. If the aircraft identity can be tied to any particular individual or purpose, then the personal journey profile of such a person is publicly traceable. This may, according to the stakeholders, conflict with the person's right to privacy or infringe upon business confidentiality. The complainants make references to mitigation means developed and deployed by FAA in the U.S. airspace.

As various stakeholders have reached out to SDM with requests for information regarding a potential implementation of a similar mechanic under the EU mandate, SDM elected to approach a number of associations catering to private and business aviation segments, with the following questions:

1) **Does your member perceive aircraft privacy to be an acute concern in the EU SPI IR implementation?**
2) **Were you able to approach any European authoritative body or agency in this context in the recent (4) years, and what was the outcome?**

The outcome of the interactions is summarized in

Table 1 below.

| Question | GAMA | IAOPA | EBAA |
|---|---|---|---|
| | *General Aviation Manufacturers Association* | *International Council of Aircraft Owner and Pilot Associations* | *European Business Aviation Association* |
| ***1. Is privacy a concern?*** | Yes, desirable to extend globally | Yes, ADS-B possibly in conflict with GDPR. | Yes, members keep voicing specific concerns. |
| ***2. Did you voice concern with EU?*** | Yes, EASA RMT.0679, it was out of scope and not addressed. | Adopted Global IAOPA resolution in 2018. Addressed the issue to EASA GenAV Committee and TF, no recommendations. Undertook local efforts and arrangements with EU MS national administrations. | Yes in RMT.0679, also discussions with GAMA, NBAA. Discussions with EUROCONTROL to raise the topic in internal groups, rulemaking and to explore the possibility of using a privacy flag in the flight plan. Would support a EU-wide solution. |

**Table 1 ADS-B Privacy survey**

SDM contends that some airspace users have legitimate interest and a just cause to pursue this matter. SDM therefore recommends to reopen the discussion on privacy concerns in an appropriate forum and therein to explore the following areas:

- Do the benefits outweigh the cost of implementation? What solutions are feasible, how complex, how effective they are?
- What legal constrains or aspects that need to be clarified (privacy as per GDPR, operational security as per 2017/373 data security and confidentiality)

SDM and EUROCONTROL will continue jointly working on this topic together with involved EU organizations. EUROCONTROL has started to address the privacy topic as part of the list of ADS-B implementation issues, and this topic will be part of the stakeholder consultation within its Surveillance working arrangements in early 2021.

## 2.7. A note concerning state aircraft

SDM conducted a survey in 2018 with the support of EDA in an effort to map the implementation plans of state aircraft operated by EU MS military organizations. Efforts to re-survey the state aircraft segment in 2020 were unsuccessful in part due to following constraints:

- Difficulty in reaching the operator organizations
- Complexity in resolving the applicability of the Regulation with regards to the definition of "transport-type aircraft"
- Great variety of special mission type aircraft present in the segment

SDM nonetheless recognizes that it is desirable that ADS-B equipage in the state aircraft segment be promoted. To that end, SDM engaged in a dialogue with EDA in order to map the known implementation constraints, which are recounted below:

- Operational security/confidentiality
    - State aircraft operators, military users in particular, are concerned that use of ADS-B would compromise sensitive operations

- Lack of technical interoperability
    - State aircraft operators lack technical means of compliance available to special mission aircraft

In order to promote the adoption of ADS-B in the segment, SDM recommends to focus resources into developing and implementing solutions that:

a) Are interoperable with the mandated 1090ES technology,
b) Allow the user to retain control of transmissions to safeguard sensitive operations,
c) Can be implemented in nonstandard/custom architectures at reasonable cost, and
d) Are functionally performance equivalent at ATM system level.

# 3. Status of ADS-B Implementation in the Ground domain / ANSPs

This chapter presents the updated status of ADS-B implementation in the ground domain. Information presented in this chapter is a synthesis of the results of the SDM 2020 ADS-B Ground Implementation Survey which was answered by all 33 ANSPs contacted by SDM. The surveys requested from the ANSPs status updates in the following fields:

- Status of current and planned surveillance systems with ADS-B capabilities,
- ANSPs' status and plans regarding integration of ADS-B in their ATM systems and the COVID-19 impact on this integration,
- ANSPs' anticipated operational use of ADS-B in an effort to capture ANSPs' long term strategic plans,
- ANSPs' view of potential use of Space Based ADS-B.
- Note: In 2020, Serbia was invited to, and participated in the survey for the first time.

In EUR airspace, the current typical surveillance infrastructure consists of both cooperative and non-cooperative sensors. For simplicity, the left side of **Error! Reference source not found.** shows the surveillance infrastructure prior to ADS-B implementation: cooperative independent surveillance layers, composed of MSSR A/C, SSR Mode S and WAM, as well as, where locally needed, the non-cooperative surveillance provided by PSR. In most of the EUR airspace, surveillance includes multiple layers of independent coverages.

On the right side of the diagram, the intended ADS-B integration is shown in the form of a contiguous layer of ADS B coverage, combined with independent cooperative sensors. While ADS-B is envisaged to substitute at least one independent cooperative layer, it is likely that in most of the EUR airspace ADS-B will be operated in complement to (at least) one independent cooperative layer. At a local level, ADS-B can be used as the sole surveillance layer (e.g. low traffic density airspace without independent cooperative layer). Similarly, non-cooperative surveillance is installed where needed and provided by PSR or multi-static PSR (MSPSR).

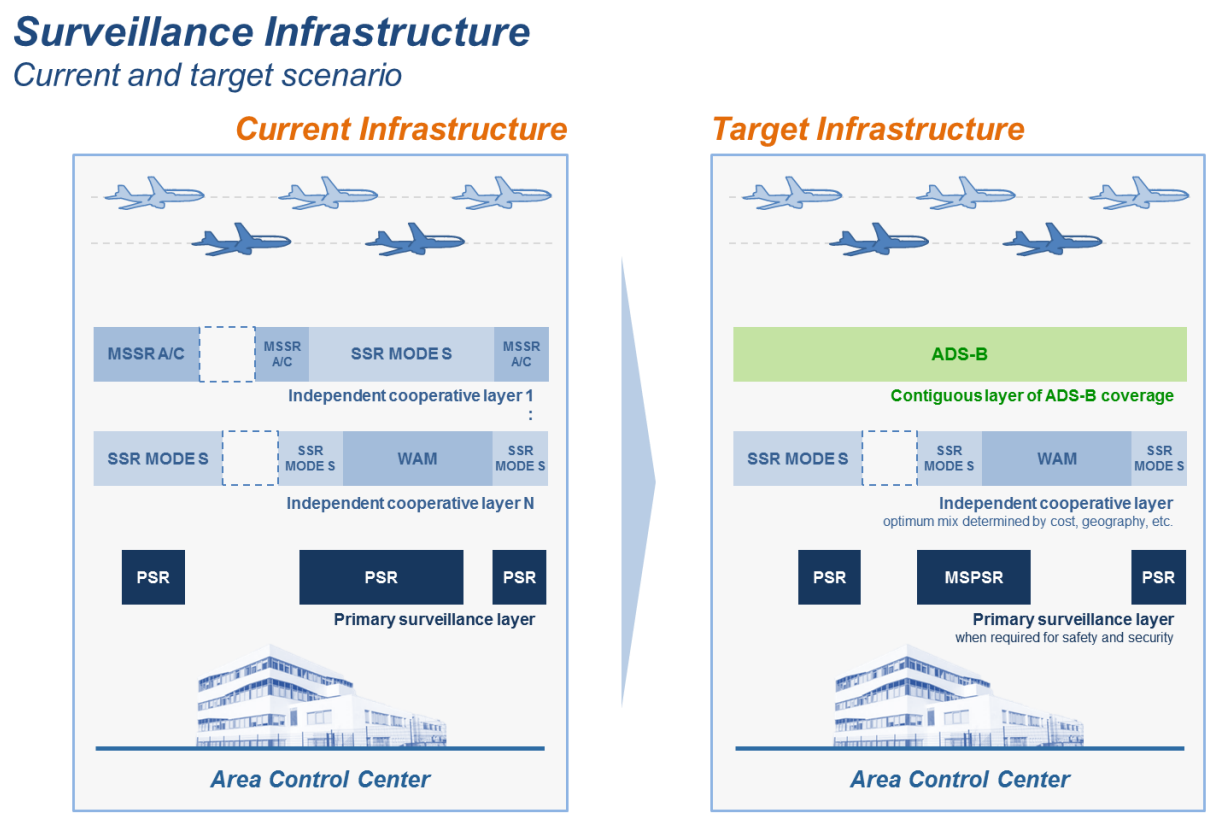


**Figure 8 Current and Target Surveillance Infrastructure in EUR airspace**

## 3.1. ADS-B capable sensor systems

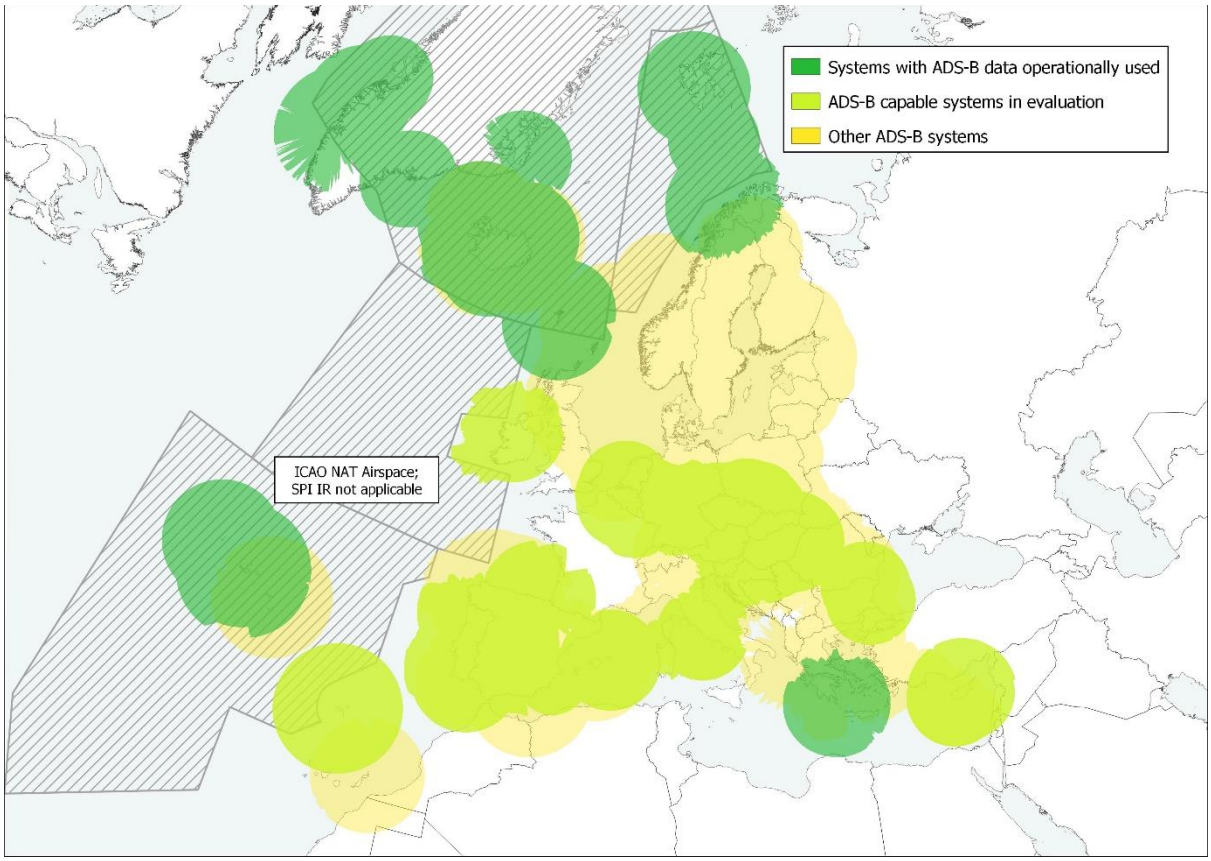


**Figure 9 Ground-based ADS-B coverage 2020 FL300**

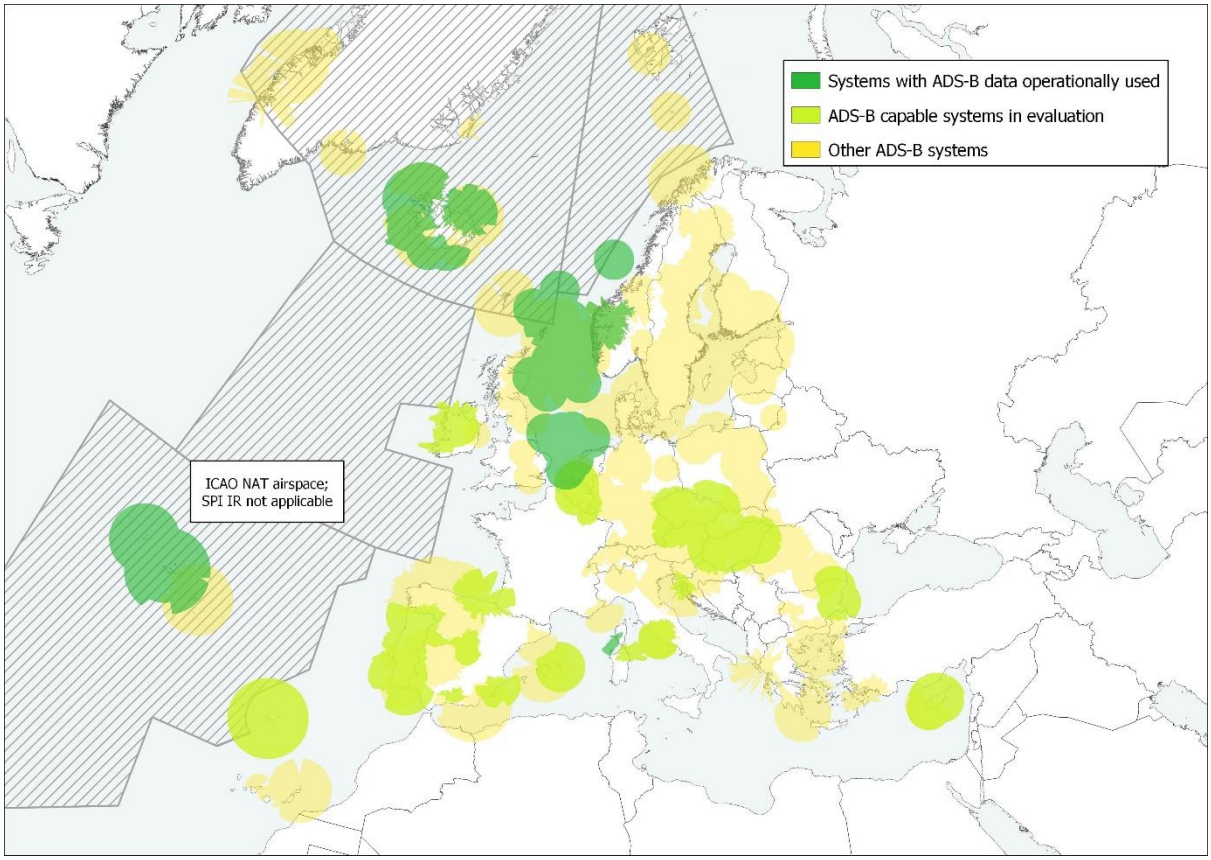


**Figure 10 Ground-based ADS-B coverage 2020 5000ft AGL**

Figure 9 and Figure 10 above show the present extent of ground-based ADS-B coverage generated by installed systems, estimated at 5000ft AGL and FL300. The coverage was modelled on top of the EU Copernicus Digital Elevation Model (DEM).

Note that:

- The coverage shown is generated by ADS-B capable systems in operational or test use. This comprises dedicated ADS-B Ground stations but also some Wide Area Multilateration (WAM) systems but also dedicated ADS-B Ground stations, airport multilateration systems and Mode S radars. Note that WAM systems, airport multilateration systems and Mode S radars without ADS-B capabilities are not included.
- The different colours are used to distinguish systems that currently support a surveillance application in airspace, systems that are undergoing trials before operations, and systems that generate coverage but currently lack a surveillance application of ADS-B.
- The sensor status is assigned based on the most advanced application present, which usually, but not always, is deployed by the ANSP operating the system and in airspace under its control. SDM supports and promotes the establishment of cross-border data sharing agreements which will be instrumental in maximizing the use of available coverage.
- The displayed coverage is provided by national ANSPs addressed by the survey.

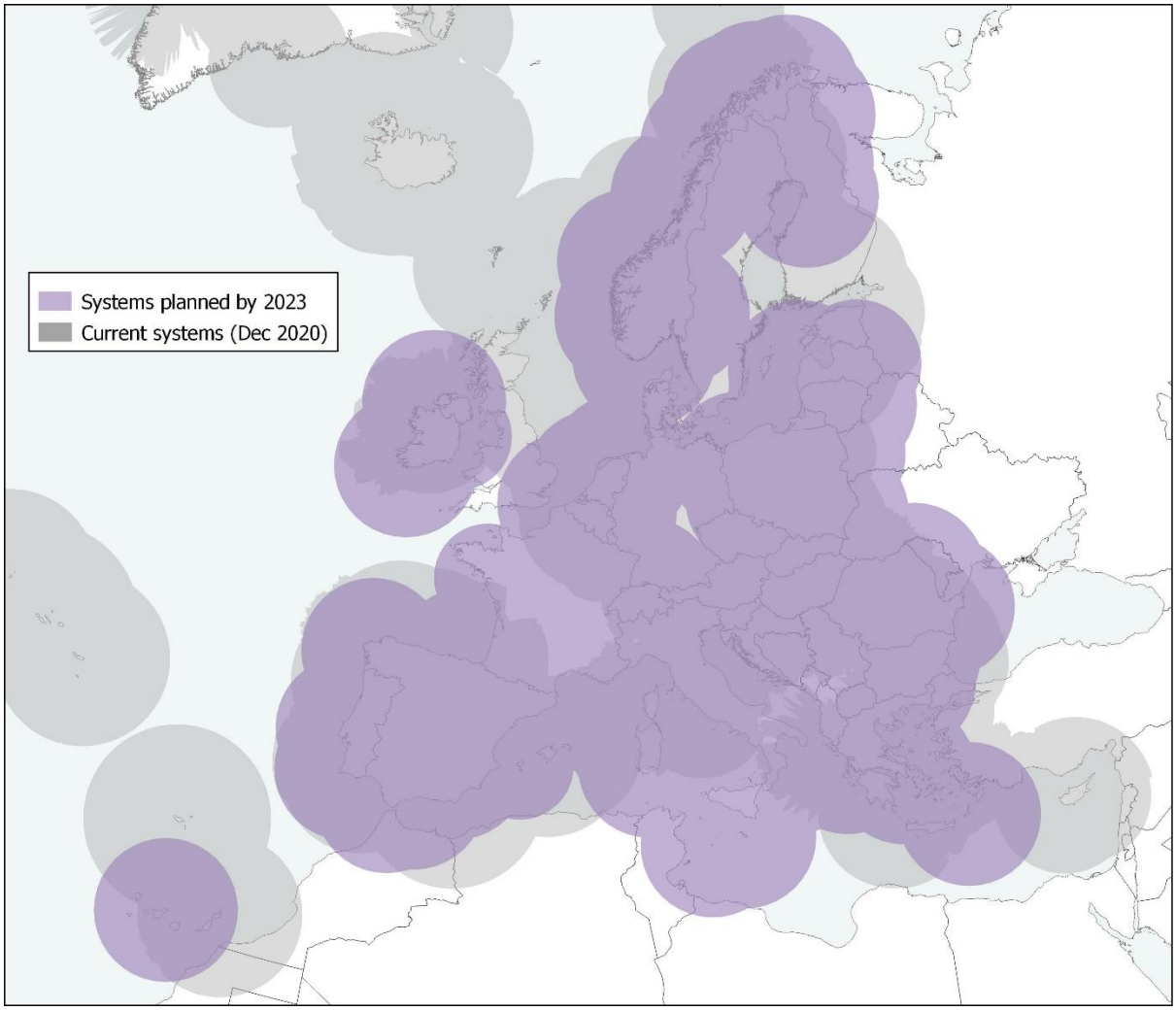


**Figure 11 Planned ADS-B coverage 2023, FL300**

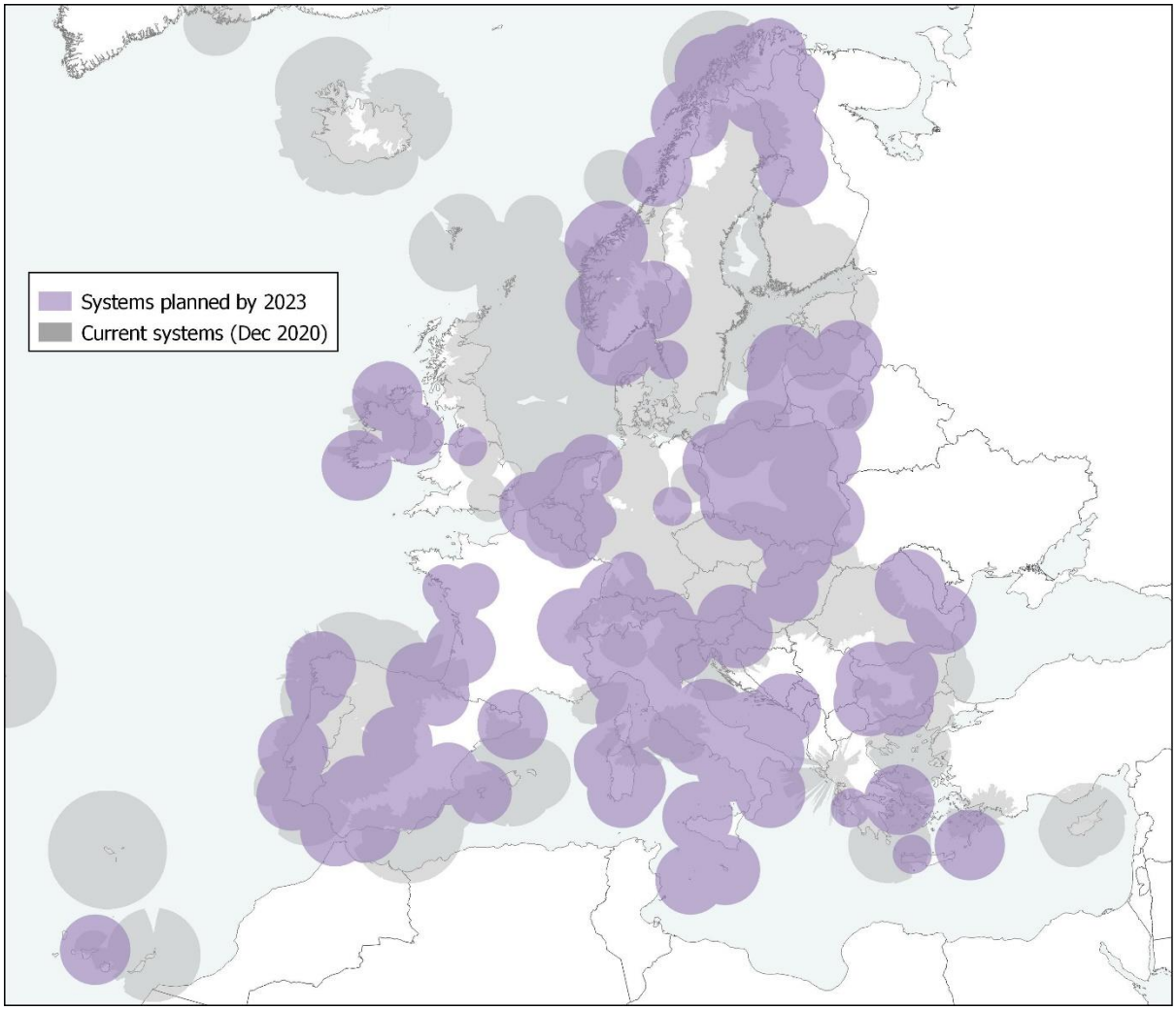


**Figure 12 Planned ADS-B coverage 2023, 5000ft AGL**

Figure 11 and Figure 12 complement the known existing ADS-B coverage picture, shown above in figures Figure 9 and Figure 10 respectively, depicted here in grey, with overlaid (purple) coverage that is planned to be deployed before end 2023.

Note that the view is not exhaustive; there exist additional known deployment activities where siting decisions are yet to be made; SDM will update the view as information emerges in the future.

## 3.2. Progress of ADS-B implementation in ATM systems

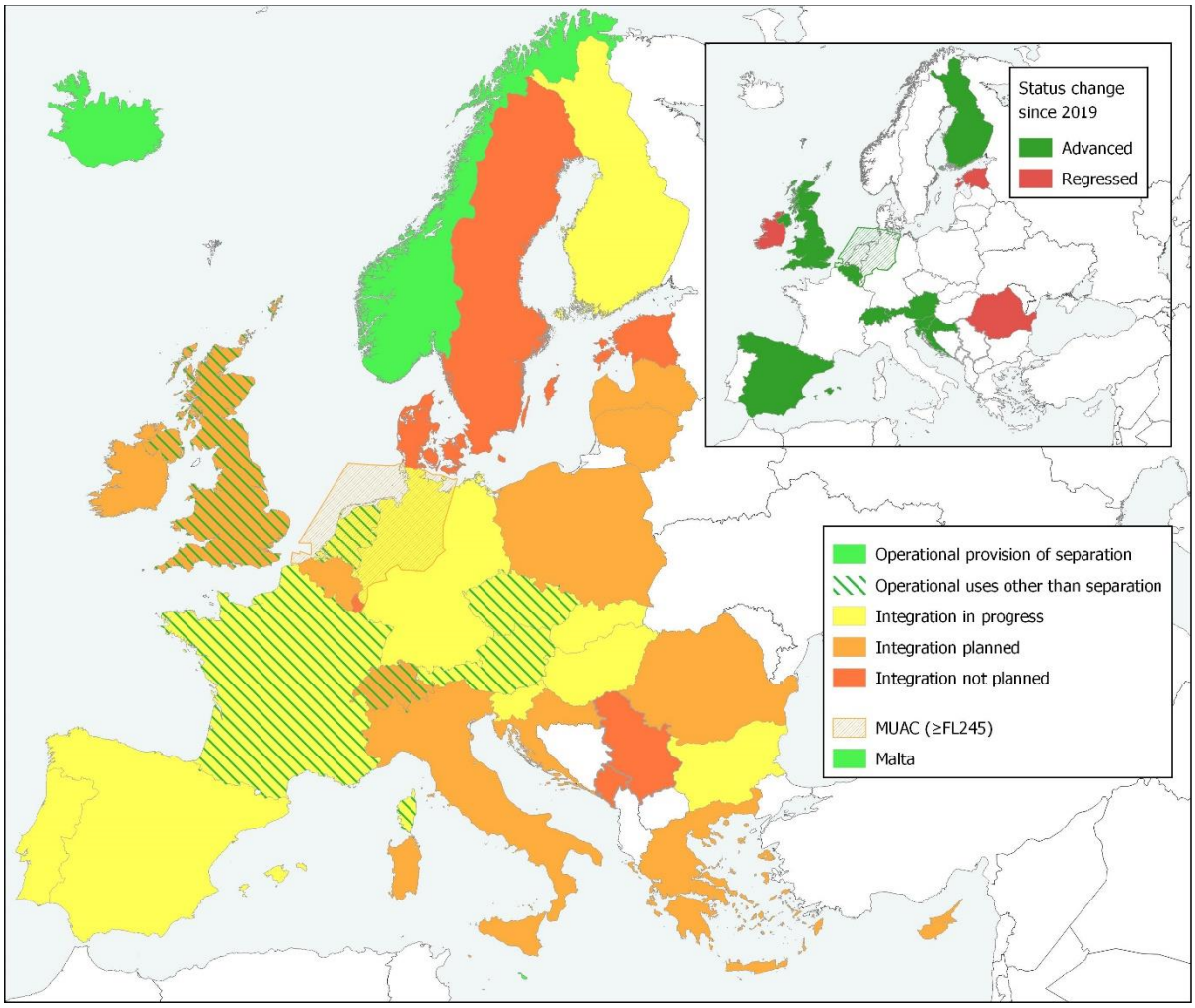


**Figure 13 ADS-B integration in ATM systems in EUR airspace**

Figure 13 shows the status and progress of technical integration of ADS-B in ANSPs' ATM systems at national level relating to service provision within ICAO EUR airspace under their responsibility, actualized to December 2020. The status assigned to each country is classified according to following logic:

- Not planned – the ANSP has no concrete plans to proceed with ADS-B integration
- Planned – the ANSP has a defined plan to proceed with ADS-B integration at any site or airspace under its responsibility
- In progress – the ANSP has undertaken concrete steps[11] to integrate ADS-B data in their surveillance infrastructure or parts thereof.
- Operational use other than separation – the ANSP is operationally utilizing ADS-B at any site or airspace under its responsibility in a limited extent, to provide Air Traffic Services other than the provision of separation. Common such uses include the provision of Flight Information Service (FIS) and ADS-B based surveillance for traffic awareness[12].
- Operational provision of separation – the ANSP has completed ADS-B integration and is using it in provision of ATC separation in a substantial geographical extent.

[11] The Appendix to the 2018 ADS-B Implementation Plan describes comprehensive and detailed deployment roadmaps for 4 different ADS-B Use Cases.
[12] The 2018 ADS-B Implementation Plan describes a list of ancillary ADS-B uses of other than separation provision for an efficient provision of the Air Traffic Services

Note that:

- There has been discernible progress since 2019. Advance was recorded for 10 ANSPs in spite of the ongoing COVID-19 crisis and the resulting changes in priorities;
- Some regression of implementation plans was also noted, the predominant cause was identified in the COVID-19 crisis and the related scheduling and priority changes; see next chapter for a detailed overview.
- In addition to the 3 ANSPs already using ADS-B for separation provision, 6 ANSPs are also utilizing ADS-B in use cases other than separation provision, while some technical tasks are still required before the provision of separation service by ADS-B can begin.
- Figure 13 presents ANSP progress at national level whereas Figure 9 through Figure 12 present geographical coverage at sensor system level. The status at national level in Figure 13 is sometimes determined based on a local use or validation activity as depicted in the coverage maps.
- Some ANSPs who are operating airspace in the ICAO NAT region, have more advanced status in the NAT airspace than in the EUR airspace. Nevertheless, only the status in the EUR airspace is depicted in Figure 13 as it is most relevant to the SPI IR.
- Use of ADS-B for surveillance of airport surface vehicles is addressed in Chapter 4.

## 3.3. COVID-19 impact on ADS-B integration

The still developing COVID-19 crisis shook the aviation industry to its core. Air navigation service providers, an integral stakeholder of the industry, were severely impacted; faced with empty skies, the absolute majority of ANSPs were forced to resort to temporary or permanent staff reductions with consequent re-prioritization of engineering efforts. ANSPs also report that customers – airspace users – now fully prioritize reduction of operating costs as the primary objective, which will further influence ANSPs' priorities. In order to capture the potential effect on ADS-B implementation, SDM approached ANSPs in the recent survey, and the synthesis of the results is presented in Figure 14.

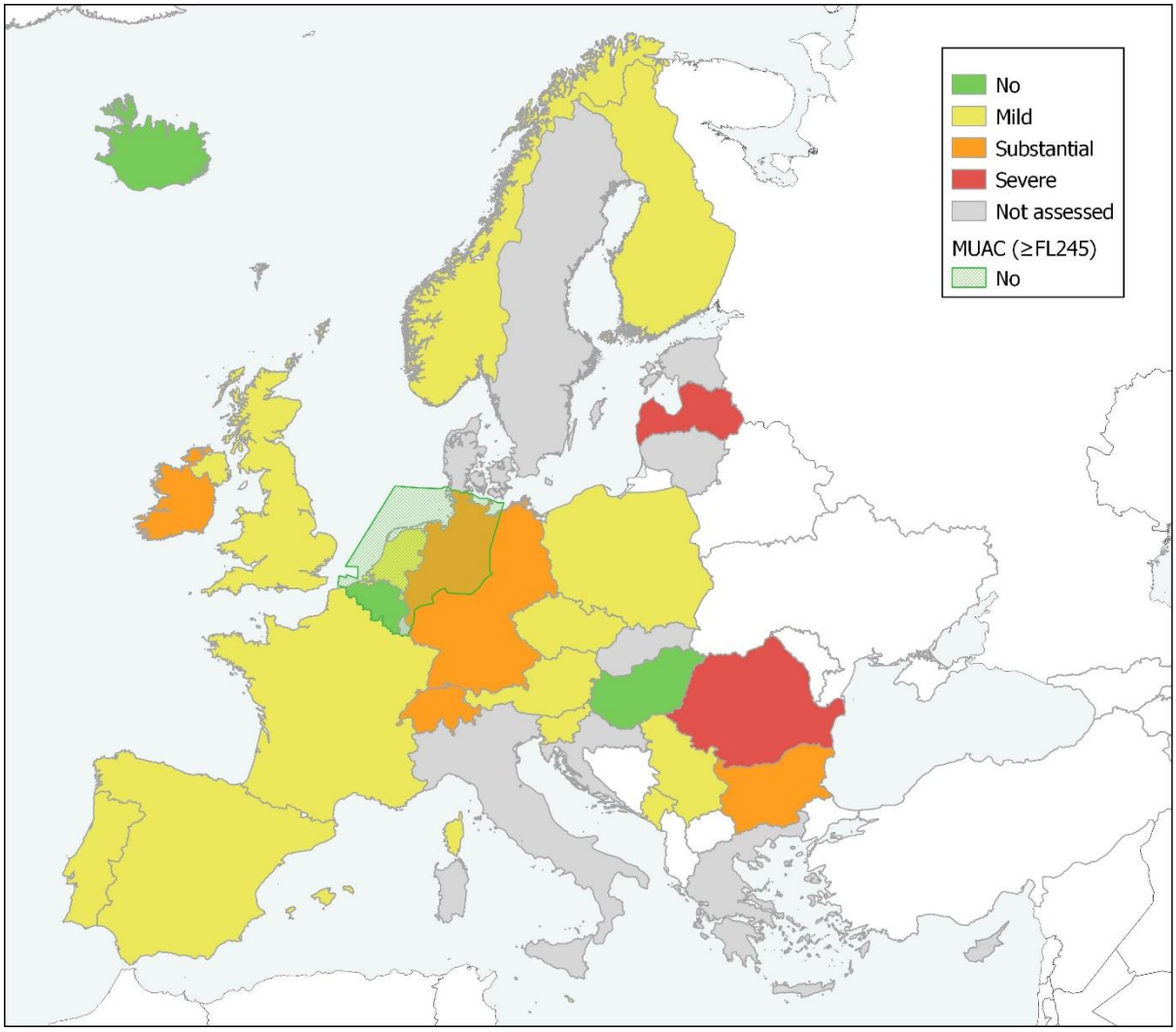


**Figure 14 COVID Impact on ADS-B implementation as assessed by stakeholders**

Consequently, SDM concludes that there likely will be a non-negligible effect of COVID crisis on ADS-B implementation efforts. The magnitude and scale of that effect is yet to be determined by how long the crisis lasts.

## 3.4. Anticipated operational use of ADS-B for ATC Separation

In the previous editions of this document SDM established year 2023 as a suitable convergence date between the airborne and ground implementations. This edition of the map shows the status and progress with increased granularity (i.e. operations planned to start already in 2021), see Figure 15 below.

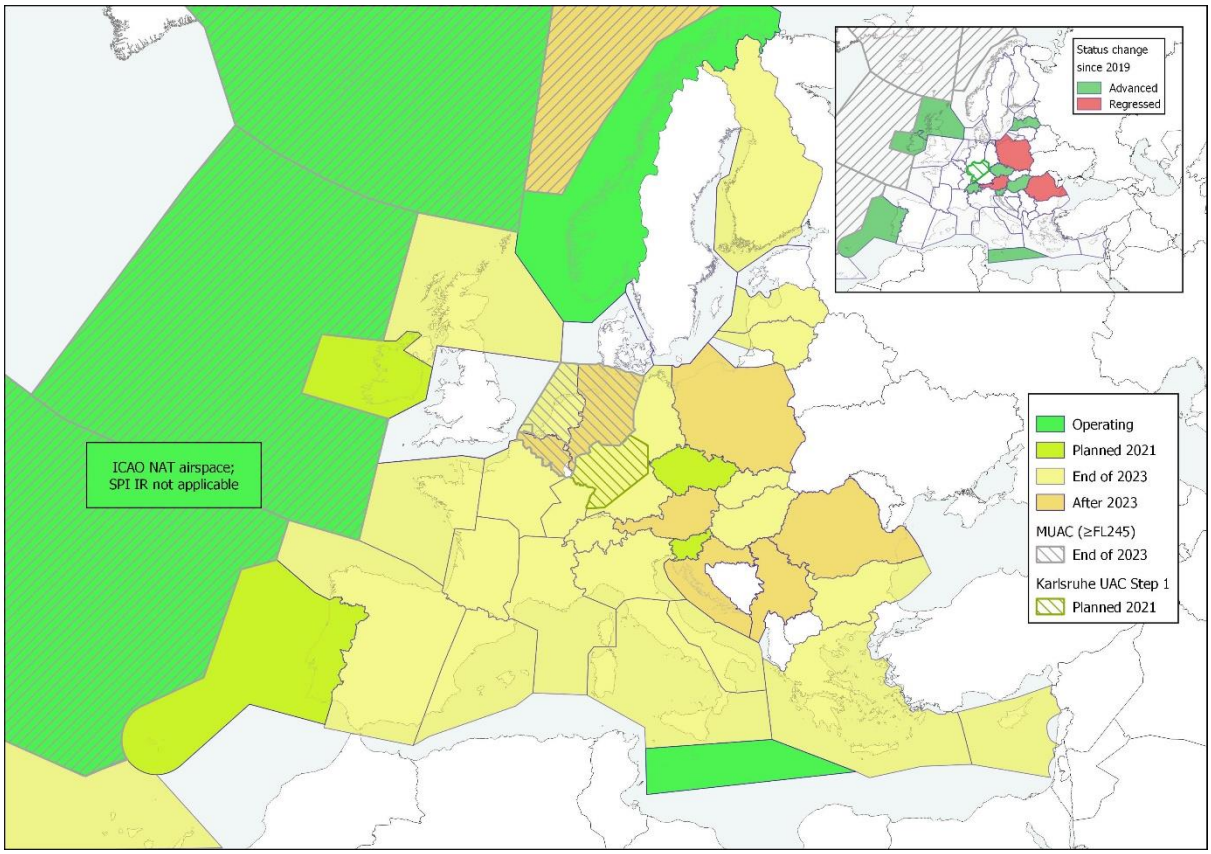


**Figure 15 ADS-B for use in ATC Separation, outlook 2023**

Figure 15 provides a generalized view of the ANSP intent to use ADS-B for ATC separation[13].

A notable progress is readily visible; two ANSPs are already using ADS-B for ATC separation within SPI IR airspace and five more are to commence provision in 2021. The trend evolution, shown in the inset top-right, underscores the positive ambition.

Some regression is again visible in the top right inset; as was the case with technical integration in the preceding section, the principal cause is delays resulting from resourcing shortages brought on by COVID-19-crisis.

## 3.5. Anticipated Application of ADS-B for the provision of ATC Separation

While there are many possible use cases for ADS-B, the provision of separation by ANSPs should be seen as the ultimate goal. In order to explore this particular deployment scenario in closer detail, SDM broke the term down to 3 distinct applications relating to separation provision. These applications can be roughly defined as follows:

- Sole Means: ADS-B alone is used to provide ATC separation in a portion of airspace. Commensurate with safety and performance standard ED-126 and ESASSP[14]
- Complementary: ADS-B in conjunction with independent surveillance is used to provide ATC separation. Commensurate with safety and performance standard ED-161 and ESASSP. Independent surveillance is typically provided by secondary radar or by multilateration, in rarer cases by primary radar.

[13] Neither the SPI IR nor this section of the document implies any requirement for ANSPs to use ADS-B data; the 2023 convergence date is to be regarded as a tentative common objective.
[14] EUROCONTROL Specification for ATM Surveillance System Performance

- Reversion/backup: ADS-B is used to safeguard the performance, primarily continuity, of independent sensors by providing a necessary measure of redundancy.

The resulting

| Separation application of ADS-B | Sole means | Complementary | Reversion/ backup |
|---|---|---|---|
| **Austria** | No | Yes | No |
| **Belgium** | No | Yes | No |
| **Bulgaria** | No | Yes | No |
| **Croatia** | No | No | Yes |
| **Cyprus** | No | Yes | No |
| **Czech Rep** | No | Yes | No |
| **Denmark** | No | Yes | No |
| **Estonia** | No | No | Yes |
| **Finland** | No | Yes | No |
| **France** | No | Yes | No |
| **Germany** | No | Yes | No |
| **Greece** | No | Yes | No |
| **Hungary** | No | Yes | No |
| **Iceland** | Yes | Yes | No |
| **Ireland** | No | Yes | No |
| **Italy** | No | Yes | No |
| **Latvia** | No | Yes | Yes |
| **Lithuania** | No | Yes | No |
| **Luxembourg** | No | No | No |
| **Malta** | Yes | Yes | Yes |
| **MUAC** | No | Yes | Yes |
| **Netherlands** | No | Yes | No |
| **Norway** | Yes | Yes | No |
| **Poland** | No | Yes | No |
| **Portugal** | No | Yes | No |
| **Romania** | No | Yes | No |
| **Serbia** | No | Yes | No |
| **Slovakia** | No | Yes | No |
| **Slovenia** | No | Yes | No |
| **Spain** | Yes | Yes | Yes |
| **Sweden** | No | No | No |
| **Switzerland** | No | Yes | Yes |
| **UK** | Yes | No | No |
| **TOTALS** | **5** | **28** | **7** |

Table 2 below gives an overview of how each national ANSP currently regards these applications for their prospective deployment scenario in EUR airspace; it is expected that these views may further evolve in the future.

Note: The applications are not mutually exclusive. A complementary use may include reversion/backup by design, and sole means and complementary may coexist side by side in the same airspace. Finally, the applications relate to separation provision alone; ADS-B will likely be used by ANSPs in a number of additional use cases, distinct from the provision of separation.

| Separation application of ADS-B | Sole means | Complementary | Reversion/ backup |
|---|---|---|---|
| **Austria** | No | Yes | No |
| **Belgium** | No | Yes | No |
| **Bulgaria** | No | Yes | No |
| **Croatia** | No | No | Yes |
| **Cyprus** | No | Yes | No |
| **Czech Rep** | No | Yes | No |
| **Denmark** | No | Yes | No |
| **Estonia** | No | No | Yes |
| **Finland** | No | Yes | No |
| **France** | No | Yes | No |
| **Germany** | No | Yes | No |
| **Greece** | No | Yes | No |
| **Hungary** | No | Yes | No |
| **Iceland** | Yes | Yes | No |
| **Ireland** | No | Yes | No |
| **Italy** | No | Yes | No |
| **Latvia** | No | Yes | Yes |
| **Lithuania** | No | Yes | No |
| **Luxembourg** | No | No | No |
| **Malta** | Yes | Yes | Yes |
| **MUAC** | No | Yes | Yes |
| **Netherlands** | No | Yes | No |
| **Norway** | Yes | Yes | No |
| **Poland** | No | Yes | No |
| **Portugal** | No | Yes | No |
| **Romania** | No | Yes | No |
| **Serbia** | No | Yes | No |
| **Slovakia** | No | Yes | No |
| **Slovenia** | No | Yes | No |
| **Spain** | Yes | Yes | Yes |
| **Sweden** | No | No | No |
| **Switzerland** | No | Yes | Yes |
| **UK** | Yes | No | No |
| **TOTALS** | **5** | **28** | **7** |

**Table 2 Currently anticipated ADS-B application for ATC Separation in EUR airspace.**

Table 2 reaffirms the SDM view that the use of ADS-B as a complementary means to independent surveillance is currently anticipated to be the predominant application.

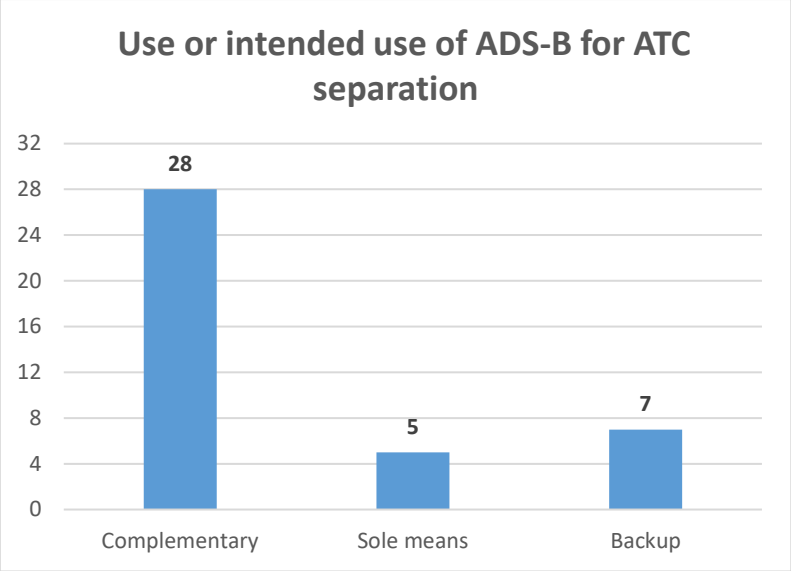


**Figure 16 Histogram of currently anticipated ADS-B separation application in EUR airspace**

## 3.6. Implementation constraints/risks

It was established in the 2019 Edition of the ADS-B Implementation Plan that ANSPs plans for use of ADS-B as depicted in Figure 15 are contingent upon a number of implementation risks – or constraints – that should be addressed and systematically managed at European level in order to de-risk European ADS-B implementation. In Figure 17 below we give a tally of the issues as identified at country level.

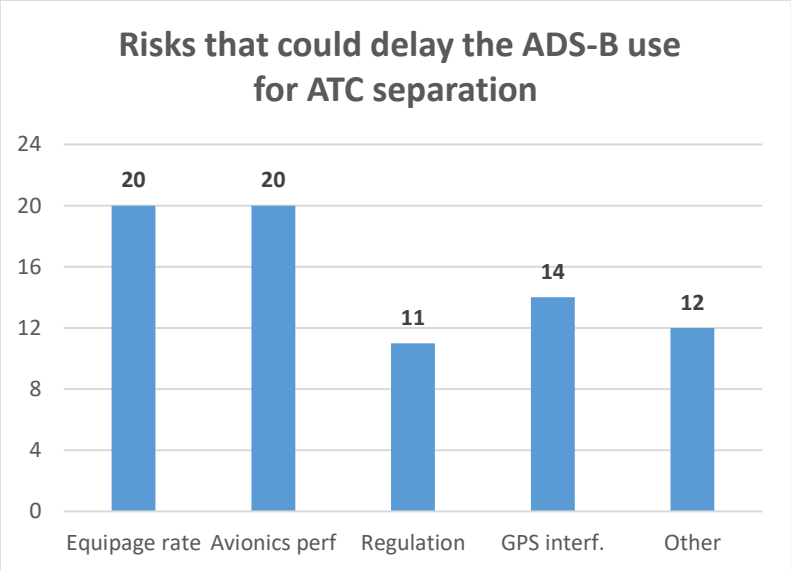


**Figure 17 Histogram of implementation constraints/risks**

In category 'Other', ANSPs reported the following examples: COVID-19 related delays, RF saturation on 1090MHz (see section 3.7), lack of mandate for lightweight aircraft to equip, scheduling with other activities competing for resources, general ADS-B performance, reliability, safety assessment, feasibility, spoofing/lack of anomaly detection, shared vulnerability with GNSS (PBN) and operator confidentiality particularly in state aircraft.

SDM is actively monitoring the progressing resolution of the identified risks. As of 2020, the status of activities is as follows:

- Regarding equipage rate, as Figure 1 shows, the equipage rate by ADS-B V2 is expected to reach 85% of mandated, EU27+4 based airframes at end 2020, and 95% at end 2023. Besides, ANSPs will also have to address the fact that a percentage of aircraft (varying depending on the airspace) will not be ADS-B equipped in foreseeable future as some apply the exemptions provided by the SPI IR and others reside outside the scope of the SPI IR.
- Regarding avionic performance, refer to EUROCONTROL SUR SG and its subgroups. Generally, the observed ADS-B V2 performance is good on an overall fleet level, however continuous monitoring to detect anomalies is ongoing and corresponding measures are taken in coordination with other stakeholders, including ICAO, ANSPs and regulators, as appropriate.
- Regarding regulatory issues and GPS interference, note the recent ICAO State Letter AN 7/5-20/89 of 28 August 2020 in which ICAO brings the subject matter to the states' attention and requests that appropriate actions be taken. A comprehensive multidisciplinary action plan proposal can be found in the attachment of the State Letter.

## 3.7. ADS-B for improved spectrum sustainability

ADS-B improves spectrum efficiency and sustainability of the 1030/1090 MHz bands. The modernisation of the ground surveillance infrastructure by implementing a mix of sensors using passive techniques[15], based on ADS-B (Mode S radars with ADS-B functionality, MLAT or ADS-B) will significantly reduce the over-interrogation of airborne equipment and the 1030/1090 MHz spectrum congestion. Similarly, the newer versions of ACAS equipment reduce the spectrum congestion by using ADS-B. The ongoing implementation of both ground and airborne systems using ADS-B is progressing rapidly, thus mitigating the 1030/1090 MHz congestion and resulting in operational and economic benefits.

[15] Passive surveillance techniques include various ADS-B based functionalities such as: ADS-B surveillance, passive acquisition in MLAT and Mode S sensors, passive acquisition of aircraft derived data (altitude, aircraft identification, selected altitude, etc.), passive multilateration, ACAS (Extended) Hybrid Surveillance or ACAS X and airborne surveillance (ADS-B IN).

## 3.8. Space-Based ADS-B

SDM surveyed the ANSPs view of potential use of Space Based ADS-B in EUR airspace. The results are shown in Figure 18.

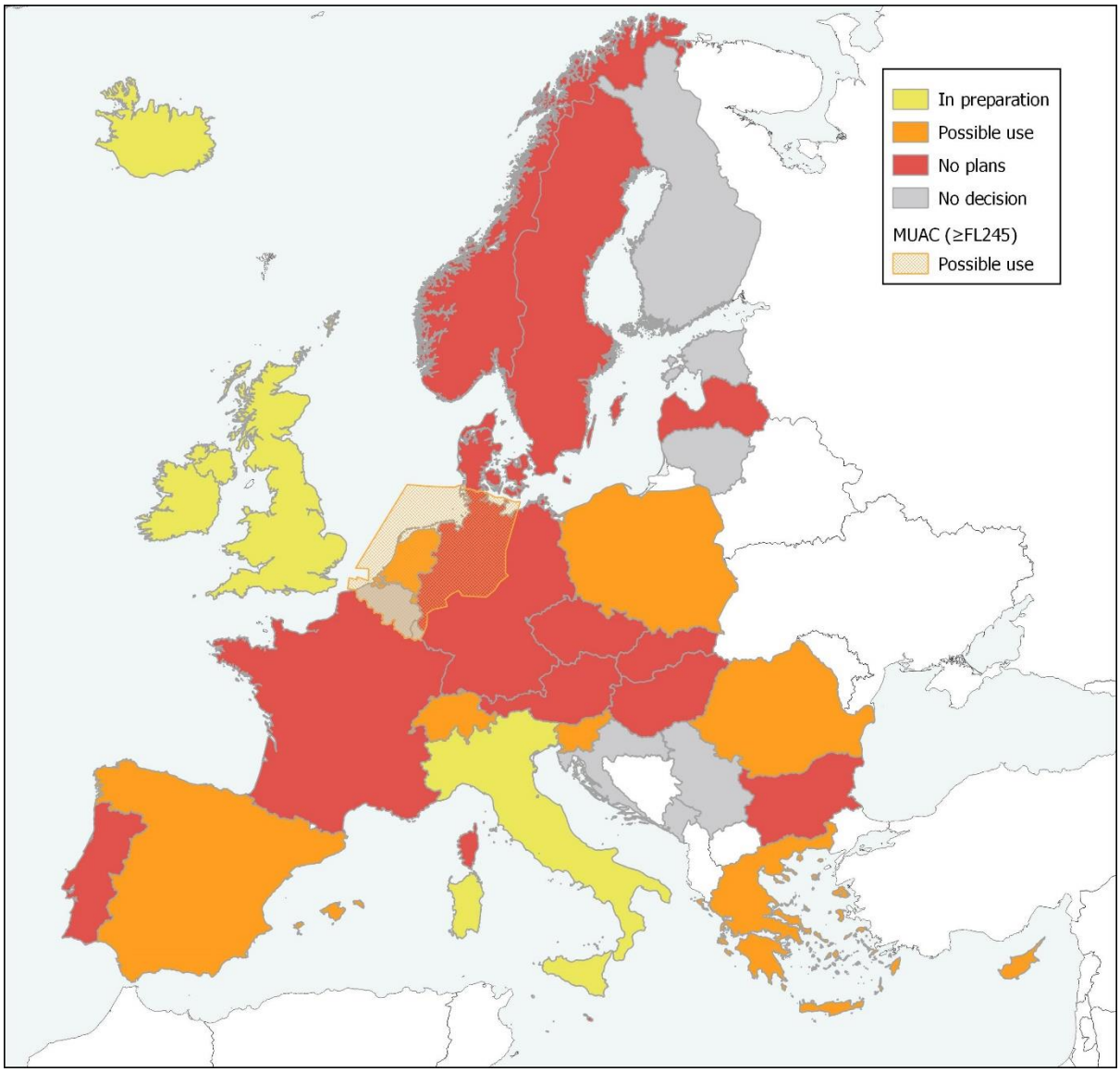


**Figure 18 ANSP view of Space Based ADS-B in EUR airspace**

- 4 ANSPs indicated that preparations for use of Space Based ADS-B are ongoing,
- 9 ANSPs indicated possible use in the future[16],
- 7 ANSPs indicated that no decision has yet been taken.

Note that specific ANSPs are undergoing, or have already completed, the deployment of Space Based ADS-B data in their systems in order to provide separation, flight information and search and rescue services in ICAO NAT airspace by specific ANSPs; this is not depicted in Figure 18.

With regards to the intended application of Space Based ADS-B, the following use cases were mentioned:

- Flow management and tactical capacity planning

[16] Note: FIR Canarias, currently resident in ICAO AFI, is expected to migrate to ICAO EUR in near future. The figure anticipates this development and classifies Spain status accordingly.

- Arrival management
- FIS provision
- Accident/Incident investigation
- In support of Free Routes Airspace absent coverage from ground-based surveillance
- Additional applications of Space Based ADS-B are under development by stakeholders other than ANSP

Concerning implementation risks for Space-Based ADS-B, ANSPs voiced pricing/CBA and performances.

## 3.9. Use of Space-Based ADS-B by EUROCONTROL

EUROCONTROL has since February 2020 started using space-based ADS-B in its applications to support performance improvements of the European ATM Network. Starting in spring 2021, space-based ADS-B data will be integrated into EUROCONTROL's enhanced tactical flow management system (ETFMS) and enable improved real time traffic predictability and associated benefits to the stakeholders, regardless of operational borders. EUROCONTROL will also use the space-based ADS-B data to support other applications, such as crisis management, contingency management, environmental monitoring, performance monitoring, post operations analysis, traffic statistics and safety-related assessments. This will contribute to improved operational efficiency, capacity, environmental sustainability etc.

# 4. Status of ADS-B Implementation at Airport level

This chapter gives information on the current use and potential applications enabled by ADS-B at airports. The data is based on a survey conducted by SDM in autumn 2020, addressing the airports in the scope of the PCP or the recently consulted CP1 proposal; this corresponds with 39 largest airports in EU27+4. At the time of writing of this chapter, 19 airports sent their responses to SDM.

All major airports have implemented a Surface Movement Guidance and Control Systems (SMGCS) for aircraft and vehicles.

At present, the aircraft surveillance systems feeding SMGCS are predominantly built on surface radar and multilateration, in some cases enhanced with ADS-B data. The most common use case is the use of ADS-B for surveillance of surface vehicles.

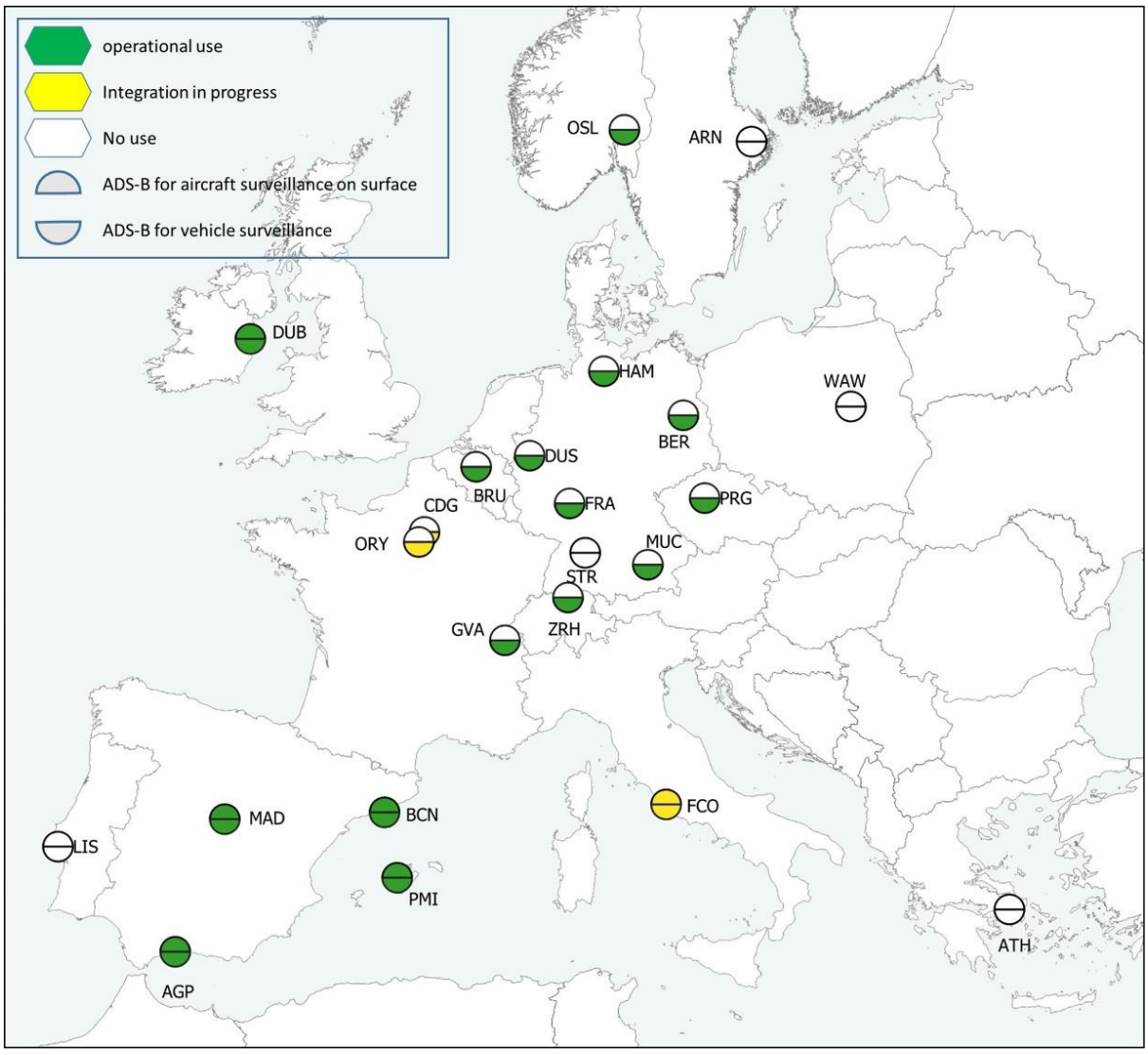


**Figure 19 ADS-B Use for surveillance at airports**

Figure 19 depicts the use of ADS-B for surface traffic surveillance at the responding airports. In addition to the PCP/CP1 airports, ADS-B is known to be used for vehicle surveillance at numerous other airports including but not limited to Brussels Charleroi, Hanover, Liege, Nurnberg and Ostrava Mosnov.

In this survey, none of the airports reported to use ADS-B as sole ground surveillance means; rather, ADS-B is employed in conjunction with other surveillance technologies, mostly SMR and MLAT. Four

of the reporting airports stated to have an MLAT system implemented with the capability to receive and output ADS-B data but at the time ADS-B data frames (Downlink Format 17) were not used to feed the surveillance chain.

While applications of SMR and MLAT are well established, the implementation of ADS-B into the surface surveillance chain started more recently. Among likely causes were lack of operator confidence resulting from inaccurate position data associated with older ADS-B version 0 and 1 (ED-102 / DO-260 and DO-260A), as well as insufficient ADS-B equipage levels.

The improvement in performances coming with ED-102A / DO-260B ADS-B systems and growing equipage levels due to SPI IR provides airports with the opportunity to exploit ADS-B to a greater extent for the purpose of surface surveillance.

In the survey, six airports reported to have concrete plans to introduce ADS-B applications into their surveillance systems.

## 4.1. Unmanned aircraft and ADS-B

SDM was asked by several stakeholders to detail out the current situation and official recommendations to equipped Unmanned Aircraft (UA) with ADS-B systems transmitting on the 1090 MHz frequency.

EUROCONTROL has performed studies on the impact on 1090 MHz occupancy from the use of surveillance equipment (including ADS-B) on Unmanned Aircraft. This work was presented at ICAO which, together with other relevant inputs, resulted in a concrete ICAO position being formulated.

In that context, SDM would like to take the opportunity of this report to reference the ICAO State Letter SP 44/2 - 19/77, "1 090 MHz spectrum issues and proper management of 24-bit aircraft addresses associated with unmanned aircraft operating exclusively at very low level" issued on 08 November 2019. In this letter, ICAO details out its recommendations to the use of 1090 MHz based ADS-B fitment to Unmanned Aircraft.

ICAO raises concerns about 1090 MHz frequency congestions and shortage of 24-bit aircraft addresses, if the use of the 1090MHz ADS-B technology is not controlled. The ICAO recommendation to the States is not to use 1090 MHz technology for Unmanned Aircraft unless the UA is operating into controlled airspace, the UA require air traffic service, or are operating in the proximity of traditional manned aircraft.

# 5. Conclusions and recommendations

On the basis of the information presented in this document, prepared by SDM in close cooperation with EUROCONTROL, **the following conclusions can be drawn**:

- As of October 2020, the monitored equipage ratio is at 80.3% with a window of uncertainty spanning from 78.7% to 81.5% due to the COVID-19 effect.

- Airborne implementation of SPI-IR is progressing in accordance with the plans reported by aircraft operators. Airspace users have adjusted their implementation plans with the most recent amendment of the Regulation and SDM estimates that, on the day of entry into force of the revised Regulation - 07 December 2020, **84.5%** of aircraft registered in EU27+4 and subject to the Regulation, will be compliant. This represents a dramatic increase overseen by the programme since its inception; in October 2018 the equipage rate stood at 25% and in October 2019 the value was at 50%.

- In 2018 SDM estimated the on-deadline compliance ratio at 73.6%, revising this estimate upwards to 78.4% in 2019. Noting that the final deadline was rescheduled by 6 months in the Regulation amendment, the projected compliance ratio **rose by over 10%** over the two years.

- Implementation in the ground domain is progressing. Technical and regulatory constraints permitting and assuming commensurate equipage levels, the majority of ANSPs indicate that they could be in position to use ADS-B operationally by 2023, largely in complementarity with independent surveillance at least in the contemporary surveillance context. Two ANSPs are already using ADS-B for the provision of ATC Separation, with additional five planning to commence operations in 2021. Others are progressing with integration and deployments towards both separation provision as well as other operationally beneficial ATM applications. Nonetheless the 2023 date and the ANSP plans need to be carefully monitored due to the potential impact of the COVID-19 crisis.

Based on the consultation performed by SDM with the different stakeholders on the proposed ADS-B implementation plan, **the following recommendations have been developed**:

- **Continue monitoring retrofit progress in the air domain with annual milestones leading up to the implementation deadline 7th June 2023.**

- **Continue to support stakeholders, manufacturers and service providers, in their efforts to fit ADS-B to the remaining aircraft under the mandate.**

- **Continue to closely monitor the ground implementation and support ANSPs and airports in their implementation efforts where necessary, and manage associated risks and mitigations at appropriate level where necessary.**

- **Continue a regular follow-up of surveillance infrastructure evolution with clear milestones.**

- **Maintain the ADS-B website (ads-b-europe.eu) as the European ADS-B Information hub serving stakeholders and the general public alike.**

- **Promote and support voluntary adoption of ADS-B equipage among traffic types not covered by the Regulation, thus contributing to improved equipage ratios in airspace.**

- **Monitor efforts to improve the robustness and resiliency of GNSS in the context of provision of safety-of-life ATM services, assess their impact on progressing ADS-B implementation.**

- **Address operator concerns regarding ADS-B and aircraft privacy.**

- **Continue to support state aircraft operators in their search for an equivalent-performant means of compliance whilst meeting mission critical requirements.**
- **Continue to promote the use of ADS-B to support the 1030/1090 MHz spectrum optimisation and regularly evaluate the related improvements.**
- **Continually assess, in coordination with the stakeholders, the impact of the COVID-19 crisis on the SPI including the transition provisions, to analyse whether and what action is required.**

SDM and EUROCONTROL stand ready to support the European Commission in any activity related to the European ADS-B Implementation plan.

# 6. List of Acronyms

| Acronym | Meaning |
|---|---|
| 1090ES | 1090 Extended Squitter |
| A4E | Airlines for Europe |
| ACI | Airports Council International |
| ADS-B | Automatic Dependent Surveillance – Broadcast |
| AIRE | Airlines International Representation in Europe |
| ANSP | Air Navigation Service Provider |
| A-SMGCS | Advanced Surface Movement Guidance and Control Systems |
| ATC | Air Traffic Control |
| ATM | Air Traffic Management |
| C of A | Certificate of Airworthiness |
| CBA | Cost–Benefit Analysis |
| CIR | Commission Implementing Regulation |
| COVID | COronaVIrus Disease |
| CP1 | Common Project One |
| CS-ACNS | Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance |
| DEM | Digital Elevation Model |
| EASA | European Aviation Safety Agency |
| EATMN | European Air Traffic Management Network |
| EBAA | European Business Aviation Association |
| EC | European Commission |
| ECAC | European Civil Aviation Conference |
| ED | EUROCAE Document |
| EDA | European Defence Agency |
| ERA | European Regions Airline Association |
| EU | European Union |
| EU27+4 | European Union Member States plus Iceland, Norway, Switzerland, UK |
| EUROCAE | European Organization for Civil Aviation Equipment |
| FAA | Federal Aviation Administration |
| FIR | Flight Information Region |
| FIS | Flight Information Service |
| FL | Flight Level |
| GA | General Aviation |
| GAMA | General Aviation Manufacturers Association |
| GAT | General Air Traffic |
| GDPR | General Data Protection Regulation |
| GenAV | General Aviation |
| GNSS | Global Navigation Satellite System |
| IALPA | International Council of Aircraft Owner and Pilot Associations |
| IAOPA | International Council of Aircraft Owner and Pilot Associations |
| IATA | International Air Transport Association |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| IR | Implementing Rule |
| MHz | Mega Hertz |
| MLAT | Multilateration |
| Mode S | Mode Selective Interrogation |

| Acronym | Meaning |
|---|---|
| MS | Member State (EU) |
| MUAC | Maastricht Upper Airspace Center |
| NAT | North Atlantic (ICAO region) |
| NBAA | National Business Aviation Association |
| NM | Network Manager |
| PBN | Performance Based Navigation |
| PCP | Pilot Common Project' |
| RF | Radio Frequency |
| RMT | Rulemaking Task |
| SDAG | SESAR-related Deployment Airport Grouping |
| SDM | SESAR Deployment Manager |
| SESAR | Single European Sky ATM Research |
| SMGCS | Surface Movement Guidance and Control Systems |
| SMR | Surface Movement Radar |
| SPI IR | Surveillance Performance and Interoperability Implementing Regulation (CIR 1207/2011) |
| SUR SG | Surveillance Steering Group |
| UA/UAS | Unmanned Aircraft / Unmanned Aircraft System |
| UK | United Kingdom |
| US | United States of America |
| V2 | ADS-B Version 2 acc. ED-102A / DO-260B |
| WAM | Wide Area Multilateration |