

FLIGHT STANDARDS DIRECTORATE
ATM/ANS & AERODROMES DEPARTMENT

Final Report

Revision of the SPI Regulation

RMT.0679 – Surveillance, performance and interoperability

December 2017



Prepared by the ATM/ANS Regulations Section

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Report

Revision of the SPI Regulation

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Executive summary

Following the identification of implementing issues with the Implementing Regulation (EU) No 1207/2011¹ (hereinafter also referred to as the 'SPI Regulation') and noting stakeholders' general support for a European ground and aircraft system mandate that is based on appropriate performance to be applied to all airborne and ground users, including infrastructure rationalisation and safeguarding spectrum, the Commission requested EASA to review, and amend as required, the regulation in terms of the underlying assumptions, expected costs and benefits, the scope and applicability and the exemptions and monitoring conditions.

A problem definition analysis, that defines and assesses the scale of a problem, the causes and the consequences was performed and the resulting analysis concluded that the significant problems were associated with lack of sustainability of spectrum (with a special focus on 1030/1090MHz) and lack of cost efficiency associated with the overall surveillance system.

Based on a series of surveys and questionnaires addressed to all the potentially affected stakeholder classes, a cost benefit analysis (CBA) was performed. However, it should be recognised that due to difficulties to derive tangible data related to state aircraft and the military ground infrastructure it was not possible to draw firm conclusions with respect to the Military in this CBA. Although it can be recognised that any further mandates would impose additional cost on these stakeholders.

¹ COMMISSION IMPLEMENTING REGULATION (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky (OJ L 305, 23.11.2011, p. 35)



The CBA estimates that over a period of 15 years, assuming that if some rationalisation of the existing en-route Mode S radars² is possible, the maximum benefits that could possibly be accumulated would be approximately 600 M€, while the cost to deploy, primarily ADS-B³ surveillance, would range from approximately 970 to 1520 M€. Thus, the overall result would be negative with a range from approximately -370 to -920 M€ for the aviation sector. No pan European operational benefits are evident, in terms of better routings or separation minima that improve the efficiency of operations, from equipping the complete European ATM system (aircraft and ground) with ADS-B. However, it is recognised that ADS-B has potential benefits that are linked to future operation concepts, such as ADS-B IN application, but these currently cannot be quantified. Furthermore no immediate safety issues have been identified that would necessitate quickly modifying the European surveillance system.

With respect to spectrum, a frequency usage analysis, indicates that the global performance of the system could degrade due to the increased use of the 1030/1090 MHz frequencies due to traffic growth and consequential increased number of interrogations. This degradation could initially occur in the core European area that is subject to high density traffic (i.e. Frankfurt – Brussels – London – Paris) between 2025 and 2030 and affect all of the European airspace by 2035. Today, studies indicate that the 1090MHz frequency is occupied at approximately 50%, and it would reach approximately 80% in 2025 and exceed 100% in 2035. This has the potential to affect flight operations and safety especially in the vicinity of this core area. Although no immediate safety issues have been identified that would necessitate an immediate regulatory response, a correctly formulated regulatory and promotional activities, in accordance with the Agency work programme, need to be defined to ensure the long term sustainability.

² It was not possible to access any further rationalisation of the Mode S infrastructure due to lack of agreement on the required performance.

³ This report only addresses ADS-B Out, i.e. transmission of ADS-B surveillance data from aircraft.



The SPI Regulation, which requires all IFR aircraft to equip with Mode S ELS, enables the use of the aircraft identification function, as required by Implementing Regulation (EU) No 1206/2011⁴ (hereinafter also referred to as the 'ACID Regulation'). This regulation requires that, by 2020, the co-operative surveillance system must be capable of identifying aircraft by the use of the downlinked aircraft identification⁵ as opposed to the traditional 4-digit Mode A code⁶. It is important to maintain the operational objective of ACID regulation due to the limited number of available Mode A code and the predicted traffic growth.

Furthermore for some State aircraft and business aviation operations the real-time tracking and identification of a specific flights, via the down linked aircraft identification feature by organisations other than ATM/ANS service providers and the subsequent display on public fora involves a security as well privacy risk.

Given the general agreement in support of a European ground and aircraft mandate, and the need to ensure the evolution of the CNS infrastructure to enable an efficient ATM system, such evolution should be supported.

Therefore noting that:

- a significant amount of work is still required to address the identified issues to ensure a safe, harmonised and cost-effective deployment of appropriate surveillance systems that is fit for all airspace users;
- no pan European operational benefits in terms of better routings or separation minima that improve the efficiency of operations are evident from equipping the European ATM system (aircraft and ground) with the ADS-B Out application;
- the evolution to an efficient ATM system needs to be initiated
- no immediate safety issues have been identified;
- the operational use of aircraft identification needs to be maintained as required by ACID regulation via the carriage of Mode S (ELS) capability.

⁴ COMMISSION IMPLEMENTING REGULATION (EU) No 1206/2011 of 22 November 2011 laying down requirements on aircraft identification for surveillance for the single European sky (OJ L 305, 23.11.2011, p. 23)

⁵ Aircraft identification transmitted by airborne constituents of surveillance systems via an air-to-ground surveillance system, which consists of a group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the aircraft call sign to be used in air-ground communications

⁶ Also known as 'SSR code', which means one of the 4 096 secondary surveillance radar identity codes that can be transmitted by airborne constituents of surveillance systems



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The Agency recommends to proceed as follows:

- 'Minor' amendment to the existing regulations to
 - introduce an exemption to permit non-compliant aircraft deliveries and operations of non-compliant aircraft under specific conditions;
 - amend the ICAO reference to amendment 77 of Annex 10 enabling the continued operation of aircraft already equipped with suitable transponders;
 - alleviate the retrofit requirements by postponing the date to 2025;
 - require the use of ADS-B data in the ground surveillance system by 2025.
 - to address the issue of state aircraft conspicuity through the use of Mode A only;
 - amend the ICAO reference to amendment 85 of Annex 10 in regulation 2017/373⁷ enabling efficient operation of the ground surveillance systems.
- The initiation of the EASA actions to support the CNS implementation of the agreed CNS evolution and the subsequent establishment of a work programme to identify the appropriate integration of all airspace users and to prepare the regulatory, promotion and supporting measures, as needed; and
- The consequent temporary postponement of a comprehensive revision of the surveillance regulatory framework, as initially intended for RMT.0679.

Based on the Cost Benefit Analysis (CBA) results and the need to establish the required performance for ADS-B, there is presently no justification to extend the mandate to other classes of airspace users (e.g. all IFR or VFR traffic).

⁷ COMMISSION IMPLEMENTING REGULATION (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011 (OJ L 62, 8.3.2017, p.1).



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1 Introduction to RMT.0679

Commission Implementing Regulation (EU) No 1207/2011 details the requirements on systems, constituents and associated procedures, within the European air traffic management network (EATMN), contributing to the provision of surveillance data. While it addresses both air and ground environment, most of the specific obligations are addressed to operators of aircraft (both civil and State) for the carriage and operation of airborne surveillance equipment and the dates by which qualifying aircraft must be equipped.

Several significant implementation issues were identified by stakeholders via consultation with the European Commission. In particular through a European Commission workshop on 7 March 2014, it was agreed to initiate a two-step approach to address these significant implementation issues which surfaced following the entry into force of the aforementioned Regulation.

- a) **Step 1:** Minimal changes to the implementing rule (IR), principally delaying effective dates for airborne equipage to provide sufficient time for a detailed review.

This was achieved on 26 September 2014, with publication of Regulation (EU) No 1028/2014⁸, with deadlines for forward fit and retro fit ADS-B Out and Enhanced Mode S (EHS) extended to 8 June 2016 and 7 June 2020 respectively. These dates were subsequently amended with publication of Regulation (EU) No 2017/386⁹ to 7 June 2020 for installation of Mode S (ELS/EHS) and ADS-B for both forward and retrofit.

- b) **Step 2:** Significant changes to the IR following a detailed review and impact assessment of:
- a. the underlying assumptions in terms of expected costs and benefits;
 - b. the scope and applicability of the regulation; and
 - c. exemptions and monitoring conditions.

Furthermore, a stakeholder workshop facilitated by the European Commission on the necessary evolution of the SPI Regulation, held on 21 April 2015, supported in general a European ground and aircraft system mandate that should be based on appropriate performance to be applied to all airborne and ground users, including infrastructure rationalisation and safeguarding spectrum¹⁰.



2 Analysis performed during RMT.0679

2.1 Summary of the issues discussed

The 'SPI Regulation' aims at harmonising the requirements that apply to the surveillance (SUR) chain¹¹ in Europe.

The SPI Regulation applies to flights that operate as general air traffic (GAT) in accordance with instrument flight rules (IFR), and to air traffic service providers (ATSPs) and communication, navigation and surveillance providers (CNSPs) involved in the operation of the SUR chain within the airspace under responsibility of the Member States.

Several implementation issues led the European Commission to consider a revision of the SPI regulatory requirements, to be proposed by EASA. These issues were reported by stakeholders and discussed at workshops, as explained in Section 1, which were hosted by the European Commission.

The 'SPI Regulation' details the requirements for the carriage and operation of airborne surveillance equipment by both civil and State registered aircraft. However, it gives flexibility to ANSP to implement the ground-based SUR solutions of their choice on condition that these are fit for purpose.

⁸ Commission Implementing Regulation (EU) No 1028/2014 of 26 September 2014 amending Implementing Regulation (EU) No 1207/2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky (OJ L 284, 30.9.2014, p. 7).

⁹ Commission Implementing Regulation (EU) No 2017/386 of 6 March 2017 amending Implementing Regulation (EU) No 1207/2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky (OJ L 59, 7.3.2017, p. 34).

¹⁰ See the Terms of Reference for RMT.0679 to obtain additional information on the relevant workshops.

¹¹ The surveillance chain consists of airborne and ground SUR systems, SUR data processing systems, ground-to-ground communication systems used for distribution of SUR data, as well as the corresponding constituents of all these systems.



This unbalanced regulatory approach has resulted in an unequal deployment of SUR technologies on aircraft and on the ground. The most remarkable example is perhaps ADS-B, which must be implemented by June 2020 on a significant population of aircraft¹², while the deployment of ADS-B stations, including the potential retransmission of ADS-B surveillance data via satellite, is uneven and depends on the preferences of ANSPs to ensure the necessary local performance. In consequence of this, surveillance cannot be predicated on the use ADS-B data throughout Europe in the short term, as not all ANSPs can process ADS-B messages in their respective areas of responsibility.

In any case, operators affected by the current mandate cannot obtain any operational benefit from the investments made to equip their aircraft with ADS-B, due to the fact that there is no mandate for ANSPs to deploy and use ADS-B data, and most importantly, there is no evidence that ANSPs are making an operational use of ADS-B data.

ADS-B use was deeply discussed during the rulemaking task (RMT) and Section 2.2 presents a summary of the main points concerning the use of this airborne surveillance technology.

In addition, other implementation issues have been reported to the European Commission and EASA. The most relevant ones are possibly the following:

- Most 'in-service' Mode S ELS transponder systems are certified to JAA TGL 13 rev 1¹³, which cannot be deemed compliant with the 'SPI Regulation', as this certification material is based on ICAO amendment 77 to ICAO Annex 10, while the SPI Regulation requires certification against amendment 85 to Annex 10.

¹² Aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots.

¹³ JAA Administrative & Guidance Material on Certification of Mode S Transponder Systems for Elementary Surveillance (LEAFLET NO 13 Revision 1).



- A lower percentage of aircraft in Europe conform to the CS-ACNS¹⁴ requirements, which is aligned with Amendment 85 to ICAO Annex 10, Volume IV.
- CS-ACNS are not fully in line with the requirements set out in the 'SPI Regulation', e.g. continuity requirements for transponders, as the requirement specified in the CS-ACNS is more demanding than the one included in the SPI Regulation and could be considered disproportionate for some aircraft, in case retrofit is needed¹⁵.
- Deviations requests that refer to the CS-ETSO-C112d¹⁶ come into conflict with the requirements of the SPI Regulation, due to the non-conformity to sections of the EUROCAE ED-73E standard¹⁷.
- The current regulation leaves little room for exemptions and, in consequence, non-compliant delivery/ferry flights are not allowed.

References to ICAO SARPs in the rule has historically been a source of implementation problems for the avionics industry. In addition, ICAO standards are subject to regular updates and there is a need to set a minimum standard for designers and manufacturers, so as to bring stability and allow that a majority of aircraft equipped with a transponder can continue to operate without performing a costly upgrade. An analysis of the differences between the latest ICAO amendments to Annex 10, Volume IV, was conducted by EUROCAE and a summary of the conclusions is included in Section 2.3.

¹⁴ EASA Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance CS-ACNS. <http://www.easa.europa.eu/document-library/certification-specifications/reg/atmans---air-traffic-managementair-navigation-services>

¹⁵ Some aircraft certified against JAA TGL 13 Rev 1 may not conform to the continuity requirement considered in the SPI Regulation.

¹⁶ EASA requirements applicable to secondary surveillance radar Mode S transponders.

¹⁷ Minimum Operational Performance Specification for Secondary Surveillance RADAR Mode S transponders.



A main concern of State aircraft and business aviation(BA) operators is real-time tracking of the position and identification of a specific aircraft by organisations that do not provide ATM/ANS. Data transmitted via Mode S and ADS-B transmissions, i.e. Mode S address¹⁸ and aircraft identification, can lead to identification of the operators of aircraft equipped with this technology.

Anyone with access to either the record of aircraft addresses or flight plan data, as well as with capabilities to receive and process Mode S or ADS-B transmissions could track and identify aircraft. It should be noted that neither Mode S replies nor ADS-B broadcasts are encrypted. Easy access to data that can be used to track flights could jeopardise privacy of the tracked aircraft and, in extreme cases, aircraft security.

2.2 ADS-B

According to EUROCAE ED-161 standard, ADS-B can support and enhance radar surveillance through the addition of ADS-B coverage in areas where radar surveillance exists and typically in dense European en route and TMA airspace. But current standards do not contemplate ADS-B as a standalone means of SUR, except in airspace that is a remote continental area with low-to-medium aircraft traffic density, oceanic airspace or areas with oil-rigs or other concentrated operations, and small islands, which is non-RADAR airspace, as per EUROCAE ED-126.

The main concern expressed during this RMT that could not be resolved was the fact that ADS-B cannot be considered a sole or primary means of SUR in most parts of European airspace, in particular in airspace that is classed as medium and high density airspace. Until this concern has been resolved, a significant number of the SSR facilities cannot be removed as a result of ADS-B technology, whose equipment cost is significantly lower than SSR cost.

Furthermore, it is important to understand the limitations of ADS-B. When it comes to performance of position determination, ADS-B position (determined on board the aircraft) can be equivalent or better than that of ELS/EHS (as determined on the ground). In fact, ADS-B benefits from a higher refresh rate, compared to SSR radars. However, it is important to bear in mind the following points:

¹⁸ Mode S address, aircraft Mode S address and 24-bit address are synonyms and means a unique combination of 24 bits that is available for assignment to an aircraft for the purpose of communications, navigation and surveillance.



- ADS-B position is not only “dependent” upon the aircraft avionics. It is also highly dependent upon the GNSS constellation, (i.e. GPS); however, the GNSS constellation is neither under the responsibility of the receiver manufacturer nor under the responsibility of the ANSP in charge of surveillance in a given airspace. Therefore, the availability of required performance ((Navigation Accuracy Category) NAC and (Navigation Integrity Category) NIC values) due to the GNSS constellation geometry and configuration (number of satellites which are operational and transmitting) could represent a limiting factor for surveillance solely based on ADS-B.
- Apart from the GNSS constellation, other factors influence the availability of the required NIC and NAC at a certain location, such as the type of the GPS receiver installed on board the aircraft with regards to the use of Selected Availability.
- The NAC or NIC unavailability's are predictable. Mitigations means based on operational limitations are possible, even though this may not be a fully satisfactory solution due to the potential impact on flight efficiency.

The GNSS position source could constitute a common point of failure for aircraft navigation and surveillance. In particular, the possibility of a GNSS outage over a given area could compromise both, the surveillance and the navigation functions, e.g. due to occurrences related to solar pulses and their strong impact on GNSS signals.

Based on the above considerations, an underpinning layer of a cooperative surveillance infrastructure, needs to be maintained to ensure the required surveillance system robustness, in particular in those areas where the airspace is classed as medium and high density.

Other developments in the field of GNSS that relate to the development and deployment of dual-frequency multiconstellation in the future, which could improve GNSS robustness are foreseen, however there is a number of technical challenges that need to be addressed before an upgrade to these systems can be endorsed. The costs of such upgrades would also need to be evaluated against the foreseen operational benefits. As this information is not yet available, this has not been assessed as part of the RMT.

The use of SBAS (EGNOS) could mitigate some of the issues related to GNSS availability, however, the low percentage of the European fleet equipped with SBAS receivers, in particular aeroplanes used in CAT operations, currently limits the benefits that could be achieved.



2.3 ICAO standards

Needless to say that changes to the applicable ICAO standards may have a significant impact on SUR equipment and operations, which has been assessed during the development of this RMT to determine whether or not changes or upgrades were needed.

With respect to impact of the different ICAO amendments to Annex 10, Volume IV, on aircraft equipage, the analysis conducted shows that:

- Most of the operational transponders are based on Amendment 77, which is perfectly acceptable from an operational point of view.
- The current SPI Regulation considers Amendment 85 as the minimum standard for transponders, which implies a challenge due to the high number of equipment that should be upgraded by 2020, as required by the current mandate.
- No operational difference exists between Amendment 85 and Amendment 89.
- Amendments 85 and 89 should not have any operational impact compared to Amendment 77 if not adopted, although they incorporate some significant improvements, e.g. in terms of spectrum protection.

In addition, there are no interoperability issues affecting ground systems, as the different amendments are compatible and, in conclusion, any combination of amendments (77-85-89), adopted differently at aircraft level and on the ground, has no operational impact on ATS surveillance, as different standards do not affect how SUR data is operationally used.

2.4 Issue analysis for the Regulatory impact assessment (RIA)

The regulatory impact assessment (RIA) conducted during the RMT was helpful to identify two problems that affect surveillance in Europe: cost inefficiency of the surveillance chain and an increasing spectrum congestion that could have an impact in the medium-term. These problems supplement those described in the sections above.



2.4.1 Problem Tree analysis

This tool allows to relate the potential problems with the causes thereof and with their consequences. The conclusions of the analysis can be then depicted with arrows that link the corresponding elements. A Problem Tree was used to define and assess the scale of the problems associated with surveillance in EASA Member States, together with their causes and the consequences. As a result, 5 main problem areas were initially identified, which were:

- lack of performance and functionality targets;
- spectrum congestion (focus on 1030/1090MHz);
- cost-inefficiency;
- lack of interoperability;
- lack of security;

The initial 'SPI Problem Tree' is shown in Figure 1, where causes and consequences were linked to the problems identified by the RMG.

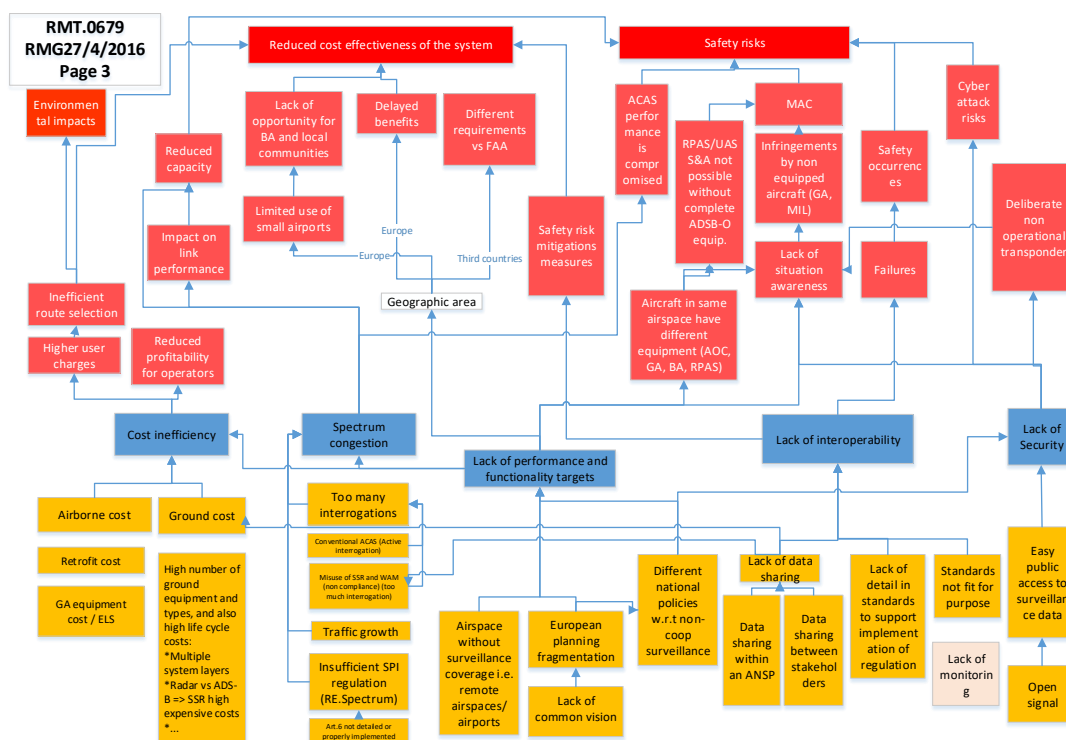


Figure 1 – Problem Tree



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With the support of the Rulemaking Group (RMG), several surveys, studies and consultations with stakeholders, were undertaken to confirm and further assess the actual significance of these problems, together with their causes and consequences. In addition, EUROCONTROL provided a report on the spectrum congestion 1030/1090MHz, to validate and complement a study performed by SESAR in 2013. The data collected and the analysis thereof is documented in the Baseline Analysis Report (see Annex III).

The analysis of the resulting material concluded that several problems were not as relevant as initially established and the significant problems were:

- lack of sustainability of spectrum (with a special focus on 1030/1090MHz)
- lack of cost-efficiency with the surveillance equipment

Therefore the RIA presented in this document focusses on these 2 problems, which are further detailed in Figure 2 below.

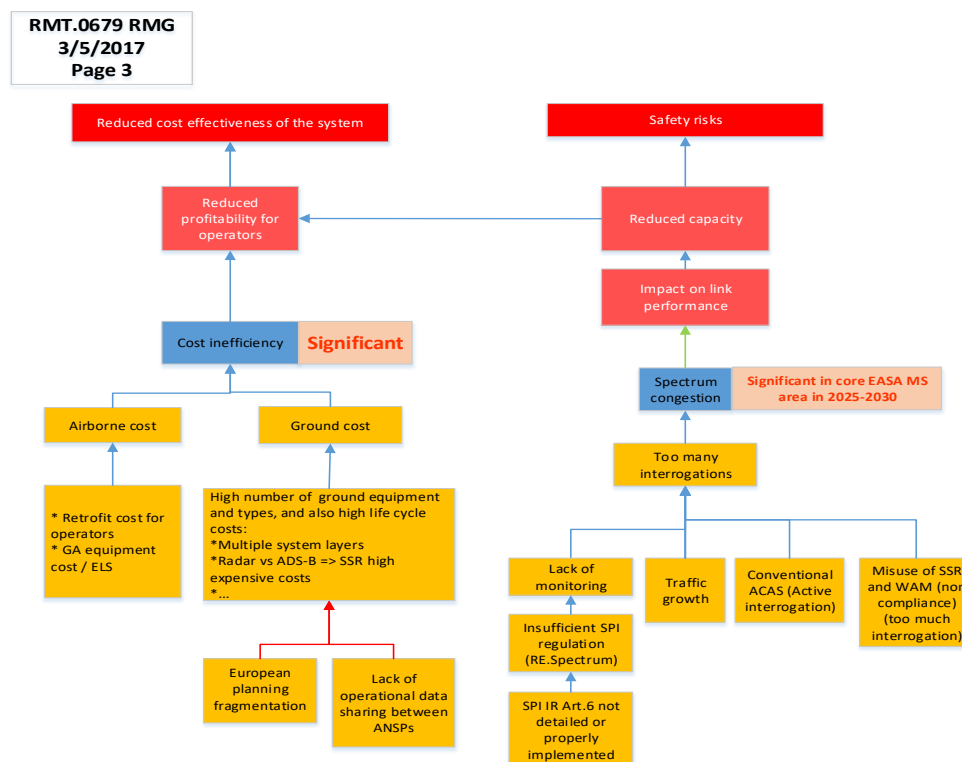


Figure 2 – Revised problem tree

2.4.2 Lack of cost efficiency with the surveillance equipment

As regards cost-inefficiency, the data collected shows a remarkable cost to retrofit the aircraft that have to comply with the current mandate, as well as a dense ground infrastructure, which is a consequence of European boundaries and the different deployment plans, which are contingent on the individual Member States' surveillance policies.

Moreover, European fragmentation results in a limited coordination to deploy an optimum ground infrastructure. In addition, surveillance data is not always shared where needed. Both aspects have resulted in coverage overlaps and avoidable costs that are afforded by the respective air navigation service providers (ANSPs) and passed on aircraft operators later on, thus making the surveillance chain cost- inefficient.

In particular, the information provided to EASA shows that surveillance data is shared between ANSPs, but there is no clear evidence of an extensive and systematic use of these data to provide ATS. On the other hand, some ANSP find legal or confidentiality issues to share data or express their doubts with regard to the quality and availability of the data from other data sources; these concerns are more relevant when the potential exchange of surveillance data involves a civil ANSP and a military counterpart (see Annex III for more details regarding data sharing).

The SPI regulation was originally adopted in 2011 with a forward fit date of 8 January 2015 and retrofit date of 7 December 2017 for the aircraft to be equipped with ADS-B and EHS . This was later postponed to 7 June 2020. One of the reasons for these postponements is related to the availability and high cost of ADS-B retrofit solutions for the IFR fixed wing fleet above 5.7 tonnes MTOW, which mainly affects Commercial air transport (CAT) and BA operators: the impact in terms of retrofit cost would have been in the range of approximately 400 to 1 400 M€ in 2017¹⁹. By postponing the requirements until 2020 in accordance with the current mandate, the previous issue of availability of equipage solutions for IFR fixed wing aircraft above 5.7 tons was addressed, but the cost impact still ranges from approximately 300 to 1000 M€ for the CAT and BA airspace users, but they would avoid spending approximately 100 to 400 M€ (more details in Appendix 1 para 3a). The estimated cost impact is shown in Figure 3.

¹⁹ Operating costs with transponder are considered very marginal, so they have not been estimated.



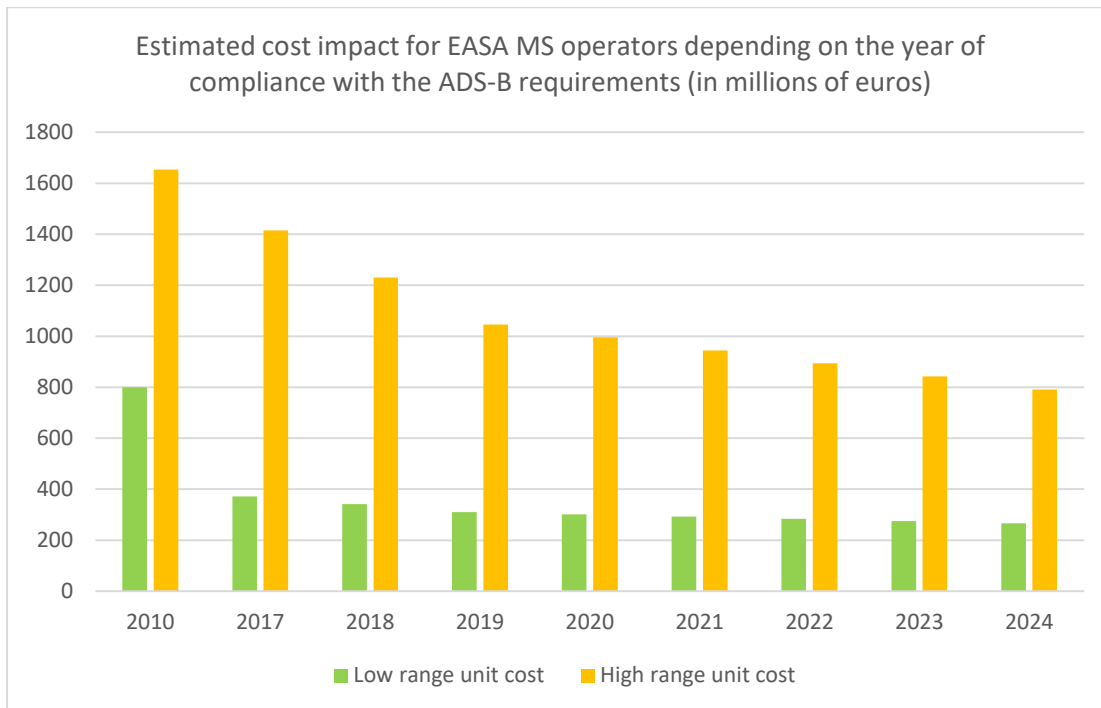


Figure 1 – CS25 Aeroplane cost (M€) impact for EASA MS Operators

There are approximately 7,300 affected aircraft operated by EASA MS operators and approximately 5,300 would need to undertake an ADS-B retrofit. According to the available data, in 2016, only 15% of the applicable fleet above 5.7 tonnes MTOW were equipped in accordance with the SPI regulation requirements for ADS-B Out. Although equipment manufacturers have confirmed that sufficient capacity exists to produce sufficient number of units to support not only the 7 June 2020 SPI mandate, but also the U.S. FAA January 1, 2020 mandate, this rate of equipage means that approximately 150 aircraft per month are required to be retrofitted to meet the 2020 deadline (see Appendix 1).

With regards to rotorcraft, despite the lack of response from rotorcraft operators to the EASA Survey, it has been estimated that the ADS-B retrofit cost for the IFR fleet above 5.7 tonnes MTOW is approximately 30 M€ (see Appendix 1).



The evidence collected, via the EASA survey, shows that SUR backbone in Europe is currently predicated on a Mode S ground surveillance infrastructure. This infrastructure is capable of delivering the necessary performance to support current operational needs, and it can already support 3NM and 5NM separation minima. However the capability to use ADS-B transmissions by the infrastructure is rather limited in Europe. The data provided shows that, 8 MS are not currently planning to either have a single ADS-B station or Wide Area Multilateration systems (WAM) capable of receiving ADS-B by 2025; the current surveillance infrastructure planning does not provide evidence that a single ADS-B surveillance infrastructure will be implemented, without any regulatory action, in the mid-term (e.g. 2025-2030). The infrastructure development plans indicate that WAM systems are to be deployed as opposed to dedicated ADS-B systems. Table 1 shows a summary of the current implementation plans and illustrates the preferred surveillance solutions adopted by our Member States in the short/medium term, and the current ADS-B and WAM deployment is shown in Figure 4.

EASA MS	Number of sensors – Estimated situation in 2025				
	Mode AC	Mode S	Total SSR	WAM	ADS-B
AUT	1	3	4	68	
BEL	2	6	8		
BGR	3	3	6	58	
CHE		7	7	50	
CYP	1	3	4		3
CZE		3	3	28	3
DEU	15	15	30	34	5
DNK	4	1	5	30	22



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ESP	10	17	27	8	3
EST			0	24	
FIN	6		6	154	
FRA		28	28	88	26
GBR		43	43	25	
GRC	9		9	6	14
HRV		4	4		
HUN		4	4		
IRL	2	6	8		
ISL	6		6		8
ITA	2	26	28		16
LTU		3	3		
LUX		1	1		
LVA		3	3		
MLT	4	2	6		
NLD		2	2	55	
NOR	4	8	12	72	15
POL	5	4	9	48	
PRT	2	7	9	82	1



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ROU	2	6	8	37	
SVK		4	4		1
SVN	1	3	4		1
SWE	11	6	17	61	
Total	90	218	308	928	118

Table 1 – Ground infrastructure implementation plans

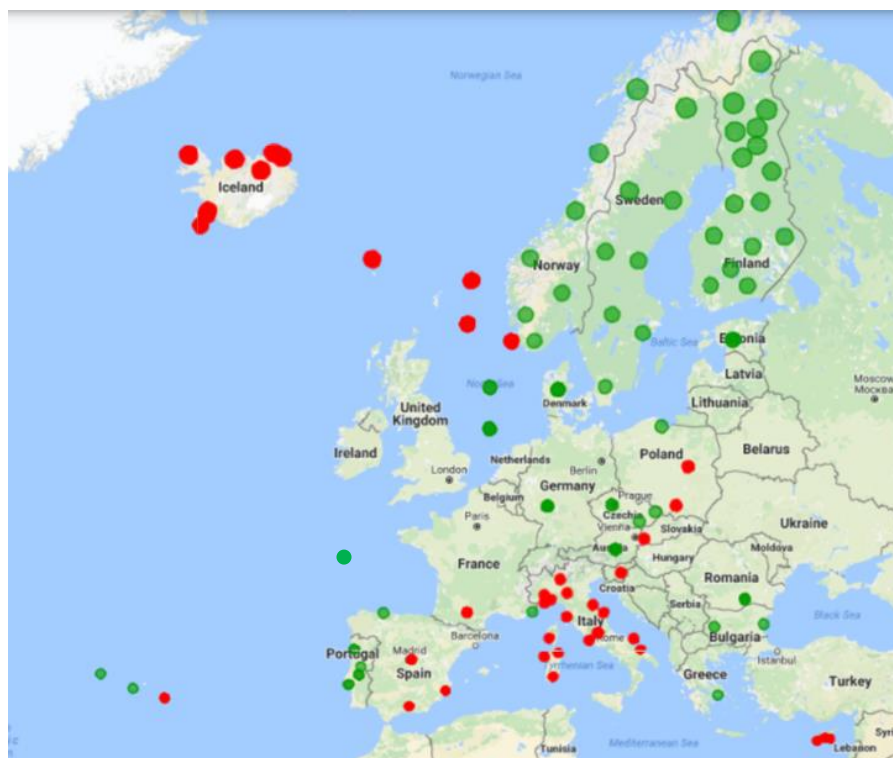


Figure 2 – ADS-B stations (red) and WAM systems (green) currently installed in EASA MS

2.4.3 Lack of sustainability of spectrum (1030/1090MHz)

Today the number of Mode A/C interrogations and responses represent the main contribution to the frequency occupations, although this Mode A/C generated frequency occupancy is expected to reduce, as the current Mode A/C infrastructure is replaced by a Mode S infrastructure²⁰. Mode S interrogations and responses and in particular the use of the extended squitter (ES) data is expected to the predominant use of the frequencies in the future. Furthermore, the predicted growth in traffic will increase ACAS interrogations and responses also resulting in a significant contribution to the frequency use. .

Any shortfall in coordination between individual surveillance systems will also have a negative impact on the use of the frequency. This effect, together with the traffic growth, translates into an increasing use of the 1030/1090 MHz frequencies, whose usage is not systematically monitored, according to the data collected during the progress of this RMT. In addition safety net performance, such as, ACAS could be compromised within a volume of airspace where the frequency becomes congested, which may compromise safety.

Traffic growth may cause saturation of the 1030/1090 MHz frequencies by 2035 and, consequently, there may be negative effect on the ability to provide ATS SUR services in a safe manner, unless traffic limitations are imposed. An analysis of the 1090 MHz frequency occupation shows that, assuming the current surveillance infrastructure and its use, the frequency degradation will start to become an issue from approximately 2025, see Figure 5:

²⁰ Reduction the generated frequency occupancy will also reduce if the rationalisation aspects of the next common project proposal are realised.



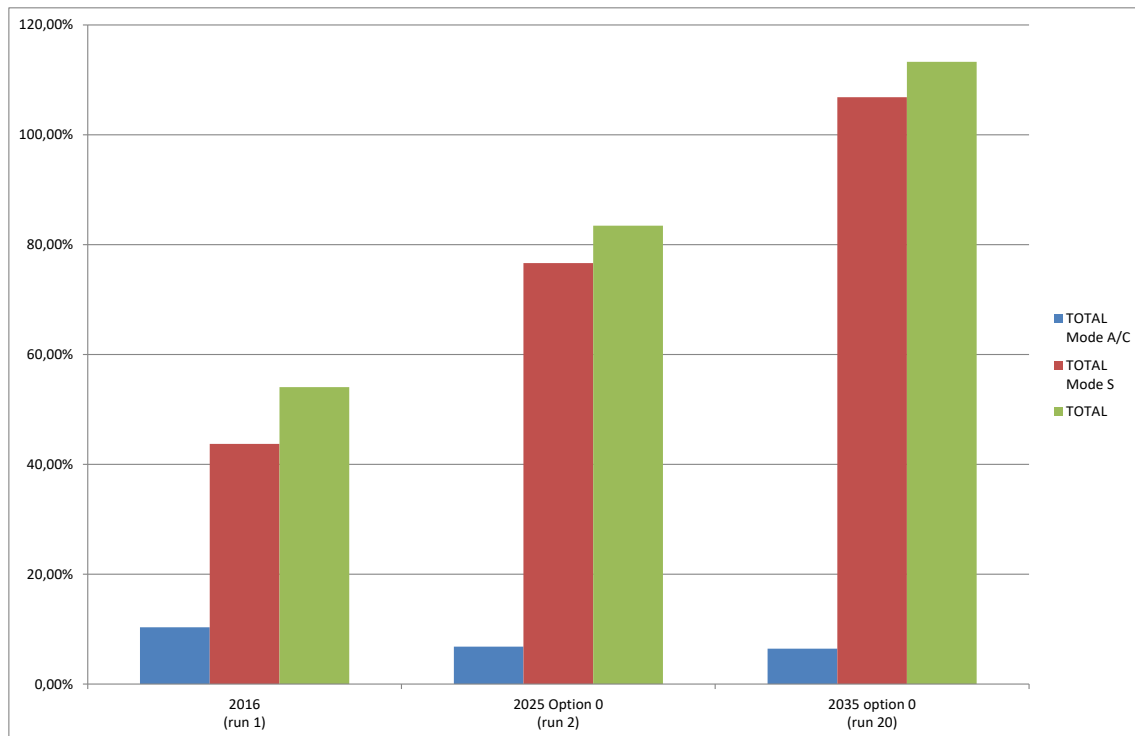


Figure 3 – Baseline trends in 1090 MHz RF band occupancy²¹

It is envisaged that this degradation would initially occur in the core European area with the high density traffic (i.e. Frankfurt – Brussels – London – Paris) from 2025. Currently the 1090 MHz is occupied at approximately 50%, this would increase to approximately 80% in 2025 and exceed 100% in 2035, as shown in Figure 5. This could have an adverse effect on safety and flight operations in this core area. This adverse effect would take place through a degradation of surveillance performance which could lead to loss of tracks, thus resulting in an increased safety risk due to potential risk of MAC and higher ATCO workload. The flight operations could be adversely affected through the subsequent application of ‘ATFM Measures’ with the aim of limiting traffic flows.

²¹ Eurocontrol report 2017, 1090 MHz RF band occupancy (pulse) 2016 – 2035 Summary Option 0.

Another factor that contributes to frequency use is the length of the Mode S messages, which is a consequence of the number of parameters requested and transmitted by the cooperative aircraft and extracted on the ground. This indicates that it is certainly necessary to limit the amount of data requested and downlinked, based on its actual use.

Furthermore the increased use of the enhanced surveillance parameters will result in the need for aircraft transponder to continually operate beyond the Minimum operational performance specification (MOPS) required by the ETSO (see Figure 6). This will also increase the probability that the surveillance system will lose the capability to track aircraft.

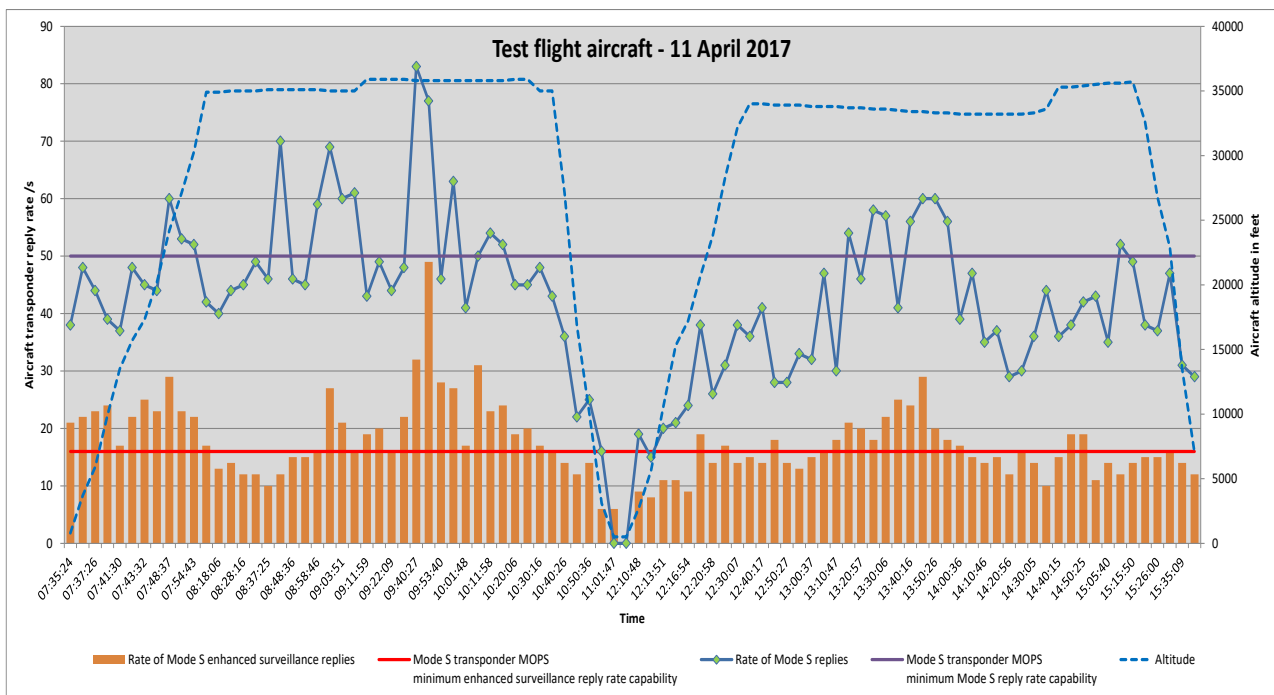


Figure 4: Rates of Mode S replies per second based on recording made on board aircraft
(test flight April 2017)

As shown in Figure 6, the surveillance system is already requiring more than the minimum capability of transponders, which must be capable of transmitting, at least, 50 replies per second, as per the MOPS²² or ICAO Annex 10 Vol IV²³. Transponders not able to reply at such an excessive rate could generate surveillance gaps, like those experienced in June 2014 where numerous aircraft were no longer detected by cooperative surveillance systems.

The management of the ground infrastructure could be possibly improved and measures could be taken in order to enhance coordination at pan-European level, so that coverage and frequency use are given the priority they deserve and a more rational use of resources can be achieved (see Figure 7). Furthermore additional actions could be undertaken with respect to the aircraft equipment, through initiatives such as a forward requirement or as part new design. However, as there is no immediate safety or operational issue, a correctly formulated action plan needs to be developed by the Agency taking into account the anticipate operations of general aviation and drones.

²² Eurocae ED-73E

²³ Standard 3.1.2.10.3.7.3, i.e. Minimum reply rate capability, Mode S.



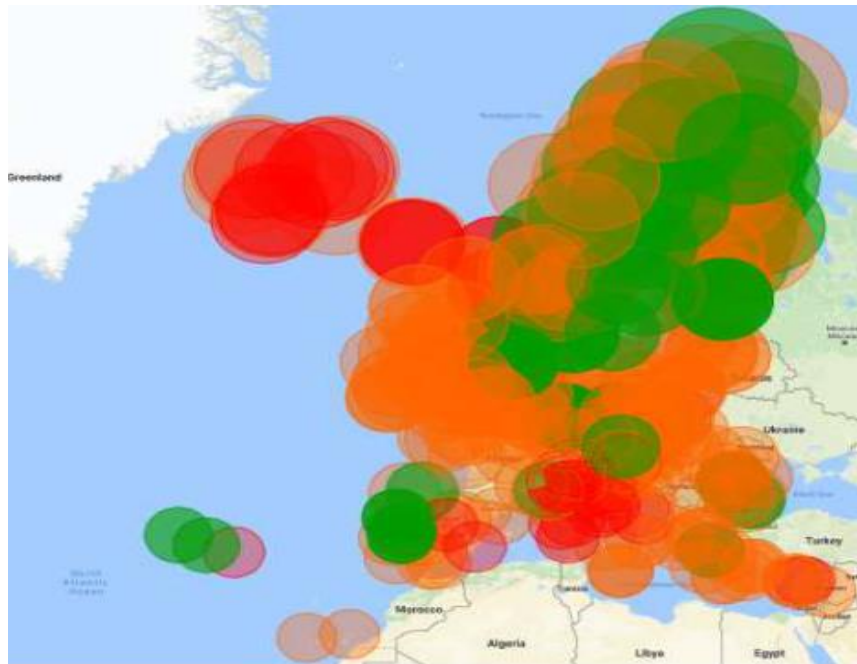


Figure 7: Current ADS-B, SSR and WAM aggregated coverage in the EASA MS FL180 (ADS-B in red, RADARs in orange and WAM in green)

2.4.4 Outline of the baseline scenario

The current SPI Regulation requires that certain aircraft must equip Mode S/ADS-B technologies as follows:

- IFR aeroplanes that are greater than 5.7 Tonnes or with a speed greater than 250 knots will need to be equipped with Mode S ELS/EHS and ADS-B Out at a cost between 300 million to 1 billion euro by 2020 (see Figure 3);
- IFR rotorcraft that are greater than 5.7 Tonnes or with a speed greater than 250 knots will need to be equipped with Mode S ELS and ADS-B Out at a cost of approximately 30 M€ by 2020;
- in all cases, IFR aircraft must equip Mode S ELS transponders, regardless of their mass and cruising airspeed capabilities.



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However, without a change to the current SPI Regulation:

- the ground infrastructure will not process and use the ADS-B signal in all the EASA MS area;
- the ADS-B ground infrastructure will continue to be implemented without an harmonised plan, preventing;
 - o an ADS-B service all over EASA MS, i.e. IFR airspace users will support the ADS-B costs without benefits,
 - o a possible rationalisation of the surveillance infrastructure,
- the spectrum congestion issue may become critical in some high density areas (e.g. Frankfurt-Brussels-London-Paris area) with potential safety implications and also the potential of 'ATFM Measures' limiting traffic flow and hence increasing in delays;
- the overall surveillance evolution in EASA MS will not be efficient.

2.5 Objectives

With the objective as defined in the term of reference to “establish a regulatory framework to ensure the safety and the cost-efficiency of the surveillance system for airspace users and allowing the integration of new technologies achieving these objectives”, 2 options were analysed.

2.6 Options

The 2 options analysed during the progress of the RMT are defined in Table 2 below. A CBA was conducted to have an idea of the impact of these two options.



<i>Option #</i>	<i>Name</i>	<i>Description</i>
Option 0	No policy change	No changes to the SPI Regulation
Option 1	Surveillance in Controlled Airspace	A cooperative surveillance system based on Mode S and ADS-B for IFR operations in airspace classes A, B, C, D & E plus VFR operations in airspace classes B & C ²⁴

Table 2 – Analysed options

With Option 1, the extension of the mandate to the ground infrastructure and other airspace users was contemplated by the RMG. This regulatory option considered that for IFR operations in airspace classes A to E and for VFR operations in airspace classes B and C the following requirements apply:

- the IFR fleet needs to be equipped with Mode S (ELS/EHS) and ADS-B -Out by 2024;
- the GA VFR fleet needs to be equipped with Mode S (ELS) and ADS-B -Out by 2027;
- the ground surveillance systems are to use both dependent and independent cooperative surveillance, i.e. ELS/EHS & ADS-B by 2025;
- a rationalisation of the surveillance infrastructure to start only after 2025²⁵.

²⁴ Due to the difficulties in identifying the relevant share of GA aircraft for these airspace classes, the whole fixed wing and rotorcraft fleet was considered in the calculation. For more information, see Appendix 1 para 3b

²⁵ Rationalisation at en-route level (>FL180) with the support of a consultant study (see Annex IVI)4)



Note 1: with respect to IFR operations, the extended mandate adds the requirement to become ADS-B equipped, regardless of the mass and speed of the aircraft; this affects IFR aircraft with MCTOM not exceeding 5 700 kg and having a maximum TAS not greater than 250 knots²⁶. In order to not alter the current regulatory criteria, based on mass and maximum cruise speed, Mode S EHS parameters would only be transmitted from aeroplanes above 5.7 t MCTOM and faster than 250 kt TAS; the rest of the IFR fleet would be ELS capable, as required today.

Note 2: as regards VFR operations, GA aircraft would have to be fitted with Mode S ELS and ADS-B transponders.

Note 3: It should be recognised that due to a controversial discussion on the availability of aircraft positioning information through GNSS with ADS-B, it was not possible to estimate the rationalisation benefits due to the integration of ADS-B into the surveillance system.

2.7 Impact Analysis

The economic criteria is the only one that has been considered in this analysis for the different options.

The data collected show that there have not been any accidents and just a few serious incidents involving, to a different extent, ATS ground SUR equipment over the past few years²⁷. Most of the incidents analysed are related to common technical problems associated with lack of flight plan correlation, loss of SUR targets tracks or false echo. As no safety issues have been identified that would require immediate action, it is assumed that safety will be maintained in all options as the methods of operation and the separation minima will remain unchanged and the spectrum congestion is to be addressed to avoid any safety issues becoming evident from 2025.

The environmental and social criteria are not considered in this analysis due to their very low significance compared to the economic criteria for this RMT.

²⁶ Particularly, rotorcraft.

²⁷ See Appendix IV, Baseline Analysis Report Section 15 Safety Analysis over 5 years. The EASA survey did not bring evidence of significant safety events over a longer period.



2.7.1 Option 0 – No policy change

This option would result in the airspace users (mainly CAT and BA operators) with high cost and no benefits. In addition the spectrum congestion may become problematic around 2030-2035 in core EASA MS's airspace. See Sections 2.4.2 & 2.4.3 for more details.

The costs corresponds to those associated with the required aircraft equipage, which are detailed in Section 2.4.4.

2.7.2 Implementation cost with Option 1 – Surveillance in controlled airspace

An approximate estimated cost for the whole EASA MS area would be between 970 to 1520 M€ over a period of 15 years, broken-down as follows:

- IFR fleet would be impacted by approximately 230 to 780²⁸ M€ in 2024, more details in Appendix 1 para 3a for CS25 fleet and Appendix 1 para 3c for rotorcraft;
- GA VFR fleet flying in Class E or above²⁹ would be impacted by approximately 350 M€ in 2027, more details in Appendix 1 para 3)b);
- Rotorcraft fleet less than 5.7t MTOW would be impacted by approximately 170 M€ in 2027, more details in Appendix 1 para 3c;
- ANSPs would be impacted by approximately 220 M€ from 2025 to 2039 with the deployment and operating costs associated with the necessary ADS-B sensors, i.e. 15M€ per year, more details in Appendix 1 para 3d.

Note 1: deferring the compliance date until 2024 for the IFR fleet will result in an avoided cost between 30 to 200 M€, due to a reduction in the retrofit costs, compared to Option 0, whose deadline for implementation was 2020; The cost to extend the mandate to GA, ANSPs and helicopters below 5.7 t and 250 kt is approximately 740M€ over a period of 15 years.

²⁸ Since in 2016, approximately 15 % of the fleet was compliant with the ADS-B mandate, so the corresponding cost, which amounts to 50 M€, is excluded from these figures accordingly.

²⁹ Due to the lack of data to identify VFR aircraft that operate in airspace Class B or C, the figure provided corresponds with the cost impact to equip the 'GA fleet flying in controlled airspace, regardless of its actual classification in accordance to the 'SERA Regulation'.



By summing the avoided cost for the IFR fleet and the additional costs for GA, ANSPs, Helicopters<5.7t and 250kt, the net cost to extend the mandate ranges from 540 to 710M€ over a period of 15 years.

Note 2: The estimated impact on ANSPs is a simplification of the ADS-B deployment cost due to a lack of consensus with respect to the required performance and ADS-B infrastructure necessary to achieve a coverage and performance similar to RADAR. Appendix 1 para 3d contains detailed information about the assumptions made. Table 3 below attempts to define the significance of these cost impacts.



Stakeholder type		Cost impact (Million Euro)	Type of cost	Annual Turnover or Budget* (Million Euro)	Relative cost impact	Cost significance in qualitative terms
CAT	aeroplane operators	200 to 750	One-off cost ³⁰	220 000	0.1% to 0.4%	Low to medium
Rotorcraft	operators >5.7t MTOW	30	One-off cost	<i>Not available</i>		<i>Not available</i>
Rotorcraft	operators <5.7t MTOW	170	One-off cost	<i>Not available</i>		<i>Not available</i>
GA users		350	One-off cost	3700	9.5%	Unacceptable
Annual ANSPs cost impact vs overall ANSP en-route charges		15	Annual life-cycle cost	8000	0.2%	Low
<i>Annual ANSPs cost impact vs the surveillance share in ANSP en-route charges</i>		15		400	3.6%	<i>For information</i>

*Sources:

- For CAT aeroplane operators, GA users and ANSPs: EASA specific contract for RMT.0679 SPI IR with ALG-ALPAC (Report Task 3)
- PRB (Performance Review Board) for surveillance share in ANSP en-route charges (approximately 5% of the en-route charges). Further details in Appendix 1 para 2b.

Table 3 - Cost significance

³⁰ Operational cost (e.g. transponder maintenance costs) are not estimated as they are considered negligible.



The cost impacts are clearly not sustainable for GA and considered medium impact for CAT operators.

With respect to the ANSPs, the cost impact does not yet integrate any potential rationalisation. Currently it is not evident how the ADS-B infrastructure cost would impact the en-route charges. Depending if the ADS-B cost is compared to the total revenues of the ANSP or only to the share of surveillance in the en-route charges (5%), the impact could be very high according EASA scale.

Moreover, the benefits to rationalise surveillance by means ADS-B are difficult to quantify, especially because the required performance and ADS-B infrastructure necessary to achieve a coverage and performance similar to RADAR was unable to be defined and the probability of detection of ADS-B messages is highly dependent on frequency use.

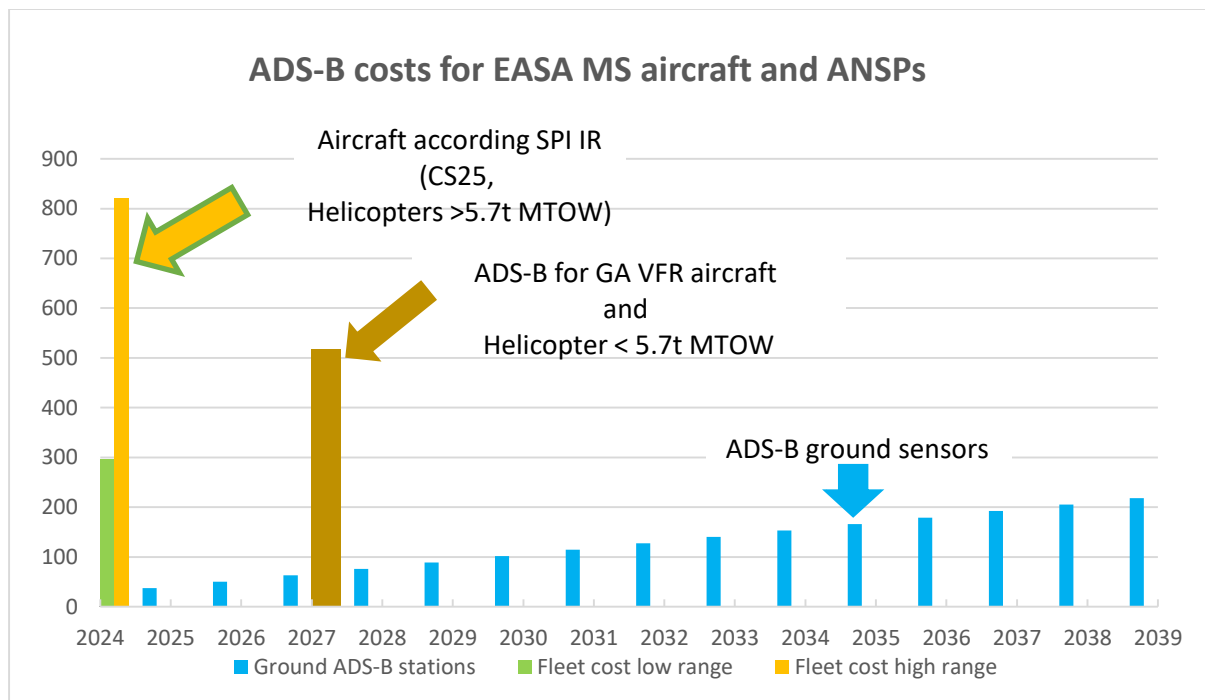


Figure 8 – Total cumulative ADS-B implementation costs (CAPEX³¹ and OPEX³²) (M€) for EASA MS aircraft and ANSPs

³¹ CAPEX stands for Capital expenditures.

³² OPEX stands for Operating expenditures.



2.7.3 Benefit Analysis with Option 1

2.7.3.1 Estimation of potential benefits with ground infrastructure rationalisation at en-route level

The following is an attempt to provide some estimation of the benefits that could possibly be achieved if SSR radars were to be and could be rationalised. This estimation is based on en-route as this the only common airspace in the EU where the same airspace classification is applied and hence the traffic type and operations are known.

- Appraisal framework for this analysis: in order to have consistent appraisal period for ADS-B and Mode S, an appraisal period of 15 years is selected. It correspond to the lifetime of an ADS-B station (the Mode S lifetime is approximately 20 years).
- Currently 191³³ SSR radars are in use only for en-route
Note: this number is certainly an overestimate (due to a coding error in the answer received by EASA and the difficulty to distinguish what is the main usage of a radar).
- Theoretical optimum: 54 Mode S radars (complemented with WAM system in high density TMAs and mountain areas to provide one layer of independent cooperative surveillance). For more details, see ALG APAC Report Task 1 in Appendix 1.
- As a consequence 137 Mode S radars for en-route could potentially be removed. These Mode S radars could be remove by not being renewed or via decommissioning.
 - ⇒ $137 \times [\text{CAPEX (1.7 M€/SSR)} + 15 \text{ years lifetime} \times \text{OPEX (0.17M€/SSR)}]$
 - ⇒ = approximately **600 M€** of avoided costs over 15 years.
 - ⇒ However this needs an ADS-B sensors' implementation of 73 stations at en-route level for 50 M€ over 15 years (see ALG APAC Report Task 1 in Appendix 1)³⁴.

³³ This figure is lower than the 207 figure used in the ALG-APAC Report Task 1 in Appendix (see Appendix 1 for detailed justifications).

Note that the estimated theoretical optimum with WAM stations in the ALG-APAC Report Task has not been considered here because the decrease in WAM stations is considered to be too high by EASA: 657 current WAM stations versus 144 with the theoretical optimum.

³⁴ 73 stations x 675 000€ of total lifecycle cost per station = 49 275 000€



- ⇒ Which means that globally the avoided cost would be around **550 M€** over 15 years: 600M€ of benefits (avoided costs) minus 50M€ of implementation costs in the context of this study performed by this consultant³⁵.

Note: However this is certainly an over estimated value due to the apparent over estimated number of SSR for en-route in the current situation and the fact that the decommissioning costs have not been included.

Caveats: There was no clear indication from ANSPs on how to estimate the number of ADS-B sensors to be implemented. The current estimates consider that 2 ADS-B sensors would be needed to complement an SSR location (except if a countrywide WAM system was implemented or Space-based ADS-B would be used). However, the report on the spectrum congestion indicates that the number of ADS-B sensors has to increase when the spectrum congestion also increases due to the reduction in the detection range. Therefore it is probable that ANSPs will decide to overestimate the number of ADS-B stations to ensure the availability of the surveillance with ADS-B in case the spectrum congestion would increase.

Finally, the degree to which ADS-B can contribute to a rationalise the ground infrastructure (SSR) is debatable due to the open discussion on the required integrity and continuity of the on board position by means of GNSS signals, in particular that airspace classed as medium and high density airspace.

2.7.3.2 Estimation of the potential benefits if the frequency congestion would be solved

The potential benefits of addressing frequency congestion will ensure the continued use of the existing surveillance technology beyond 2030. Thus no new investment in additional technology would be required, therefore ensuring the continued operations of existing investments.

³⁵ However, note that the implementation costs in the framework of the study performed by the consultant was not retained because this estimate is not accepted by the ANSPs and the only agreement with ANSPs to estimate an implementation cost for ADS-B stations was made with another approach: see section 3.7.2.



Further consolidation of the frequency occupancy would potentially ensure the availability of the 1030/1090 MHz frequencies. This could be achieved for example through the optimisation of:

- ACAS II replies;
- Mode S EHS replies (Long Roll-Call);
- Mode S radar acquisition replies (All call replies).

a) ACAS II replies

Analysis shows that the interrogations made by ACAS II to be a significant contributor to the frequency utilisation. Therefore if Extended Hybrid ACAS surveillance which is dependent on ADS-B Out, could be implemented from 2025, the frequency utilisation could be similar to that of the situation today, i.e. acceptable/manageable: as shown in Figure 9.

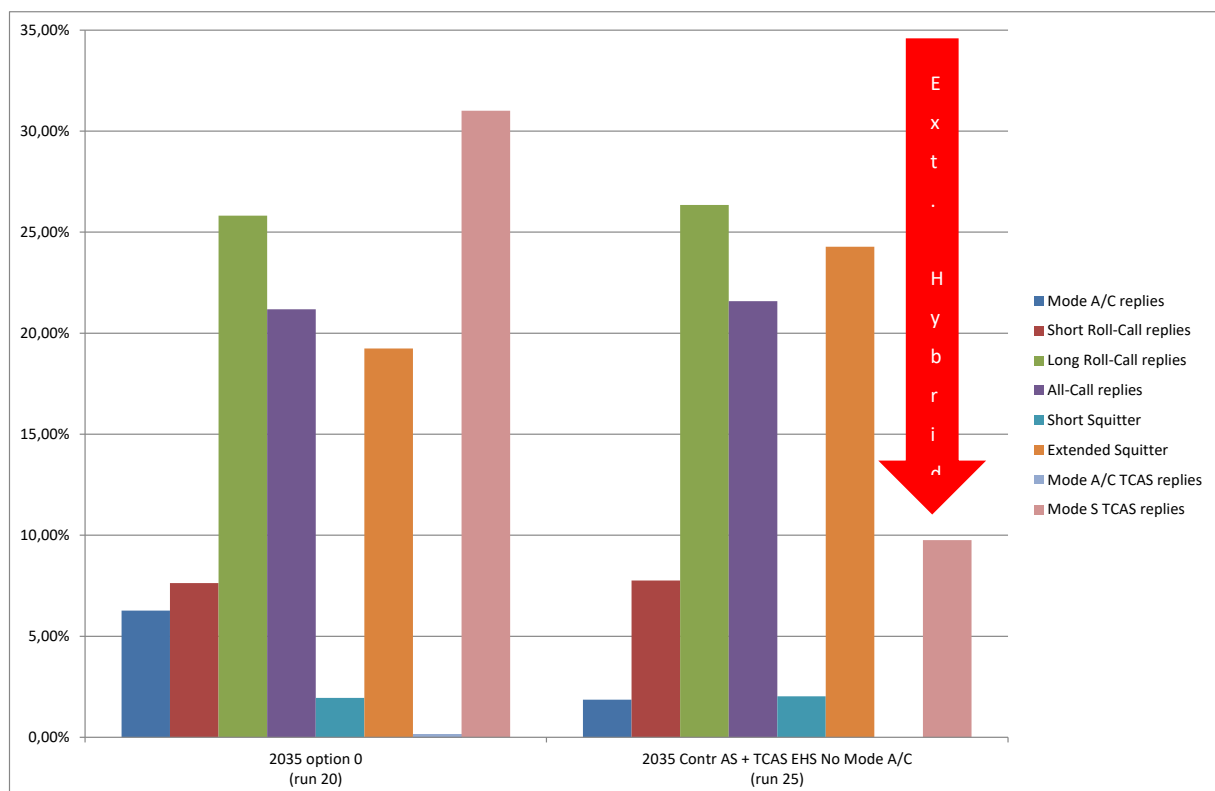


Figure 9 – 1090 MHz occupancy in 2035 comparing the baseline scenario (Option 0) and a scenario with Mode S EHS/ADS-B/ACAS hybrid surveillance in controlled airspace

b) Mode S EHS replies (Long Roll-Call)

One means to reduce the frequency utilisation associated with Mode S EHS would be to limit the active extraction of the Mode S enhanced parameters, as most of these parameters are also included in ADS-B transmissions.

c) Mode S radar acquisition replies (All call replies)

Potential areas to improve the frequency utilisation resulting from Mode S radar acquisition are:

- Reduction of the number of Mode S all call interrogations transmitted by Mode S radar:
- Optimisation of Mode S all call lock-out coverage
- Clustering of Mode S radars

d) Frequency congestion conclusion

If the above actions were to be implemented, and even only based on the current traffic situation in EASA MS, the current flight capacity of the core airspace would be secured and safety would be ensured.

The cost to reconfigure the radars, to upgrade the data processing and tracking systems or aircraft equipage has not been assessed nor the implementation time frames.

2.8 Conclusions for the Cost Benefit Analysis with Option 1

2.8.1 Cost associated to the extension of surveillance to controlled airspace

A rough estimated cost for Option 1 throughout EASA MS area would be as follows:

- The impact on the aeroplane operators of the EU CS25 IFR fleet would be approximately 200 to 750 M€ in 2024;
- The impact on the operators of the GA fleet would be approximately 350 M€ in 2027;
- The impact on rotorcraft operators is estimated to be 30M€ for the fleet above 5.7t MTOW and 170M€ for the fleet below 5.7t MTOW;
- The impact on ANSPs would be approximately 220 M€ from 2025 to 2039 for the investment and the operating costs for ADS-B sensors;
- Total implementation costs over a period of 15 years would range approximately from 970 to 1520 M€.



2.8.2 Cost-Benefit Analysis assuming surveillance rationalisation at en-route level

A rough estimated cost for Option 1 throughout EASA MS area would be as follows:

Over a period of 15 years, assuming the en-route rationalisation envisaged in Section 2.7.3, the maximum benefits would be approximately 600 M€, with an implementing cost range from approximately 970 to 1520 M€, the overall result would be negative with a range approximately from -370 M€ to -920 M€ for the aviation sector as shown in Table 8.

CBA item	Minimum range	Maximum range
Capital and operating costs	970 M€	1 520 M€
Benefit (en-route surveillance rationalisation)	600 M€	600 M€
Total (Benefit – Cost)	- 370 M€	-920 M€

Table 8 – Option 1 CBA over a 15-year period (without discount rate)

*Caveat: a Cost-Benefit Analysis should apply a discount factor to the annual cost and benefits (rate of 4% in the EASA methodology). Most of the costs occur on year 1 in this analysis, so the cost information in the table above provides a good approximation of the Present Costs. Benefits with radar removal (avoided CAPEX and avoided OPEX) will occur over the period, this should be subject to the discount rate and will have the consequence to decrease **significantly** the benefits indicated above. Globally the Cost Benefit Analysis would have a more negative outcome. The discount factor was not applied to keep the table easy to read as the discount factor does not change the outcome.*

3 Analysis of RMT.0679 Options

The two regulatory options that have been analysed provide a view with respect to the cost and benefits that could be achieved, based on the assumptions made. However, there are other issues that need to be taken into consideration in order to ensure an effective solution.



3.1 No policy change – Option 0

As introduced in Section 2.1, a significant number of aircraft have already been equipped with transponders in order to be compliant with the regulation, i.e. ICAO Annex 10 Volume IV, Fourth Edition including all amendments up to No 85, and for which deviations have been granted to the ETSO article. These deviations were issued under the condition that, given the current operation environment, safe operations should be ensured and that exemptions would be granted. The aircraft with these transponders installed will require a further upgrade to be compliant, as under the current regulatory provisions no exemptions are possible.

Also as introduced in Section 2.1, it should be recognised that a high number of ELS aircraft were certified against JAA TGL 13 rev1, i.e. based on ICAO Annex 10 Volume IV, Third Edition including all amendments up to No 77, which cannot be considered compliant with the SPI Regulation. Though these requirements are technically sufficient to support operations and interoperability in EASA MS areas changes to these aircraft would be required and would also represent an unnecessary burden.

Furthermore, the current exemption provisions, do not permit the delivery of aircraft from European manufactures for operation in non-European airspace. This places an undue burden on the manufactures.

A majority of aircraft already equipped with a transponder can perform safe operations in the EASA MS airspace and unnecessary cost and administrative burden could be avoided.

The equipage of aircraft in accordance with the regulation, in particular Mode S ELS, supports the operations required by the 'ACID Regulation'. This regulation requires that by 2020 that surveillance system is capable of identifying aircraft by the use of the downlinked aircraft identification as opposed to the traditional 4 digit Mode A code. It is important to maintain this operation due to the limited number of available Mode A codes.

It is therefore apparent that Option 0 is not a valid option as changes to the regulation are required.



3.2 Surveillance in controlled airspace – Option 1

This option only addresses that of controlled airspace and IFR/VFR operation that are provided with a separation service; it does not address those operations that only receive information or traffic avoidance advice in accordance with the airspace classification, as defined in SERA. It should also be noted that there is not a uniform application of airspace classification and the traffic mix is extremely varied throughout Europe. Thus, at this stage, imposing mandatory equipment carriage requirement may not be proportionate to the airspace operations, especially for VFR traffic in Classes B & C.

As shown above this option extends the use of Mode S and ADS-B technologies to a wider range of users and makes the use of ADS-B within the ATM system compulsory. The uptake of ADS-B and ELS/EHS data would provide, when fused together, an enhanced surveillance picture for the ATCO. However, it should be recognised that this enhanced surveillance picture will not permit any improvement in service (i.e. separation minima remain unchanged, routings remain unchanged), thus no operation benefits can be derived. Although, it is recognised that ADS-B has potential benefits that are linked to future operation concepts, such as ADS-B IN application, these benefits cannot be quantified.

Furthermore, in response to short term outages of GNSS, the draft European Commission Navigation strategy states: “Finally vectoring by ATC using surveillance technology, to an airport with an ILS approach or visual conditions, will provide the final recourse to navigating especially in areas of low traffic density”. As ADS-B position³⁶ is based on the same data source as that used for navigation, in order to achieve this objective, an independent cooperative surveillance source will need to be maintained, Figure 10 shows the current independent cooperative surveillance coverage, which indicates that most of Europe is already covered by an independent cooperative surveillance means, thus being able to meet the navigation objective, though the number of overlaps is excessive in some cases, which indicates that a joint strategy to deploy surveillance resources is needed.

³⁶ Section 2.2 provides additional inputs with respect to ADS-B usage and can complement statements made in this section.



The situation becomes even more complex in that the current standards for ADS-B use in medium to high density airspace is for complementary use to enhance the surveillance service. This means that ADS-B currently cannot be used as a direct replacement for independent cooperative surveillance in a significant portion of the European airspace that as can be seen from the airspace density distribution as shown in Figure 11.

These elements hinder the extension of the mandate and rationalisation of the ground infrastructure in the short and medium term.

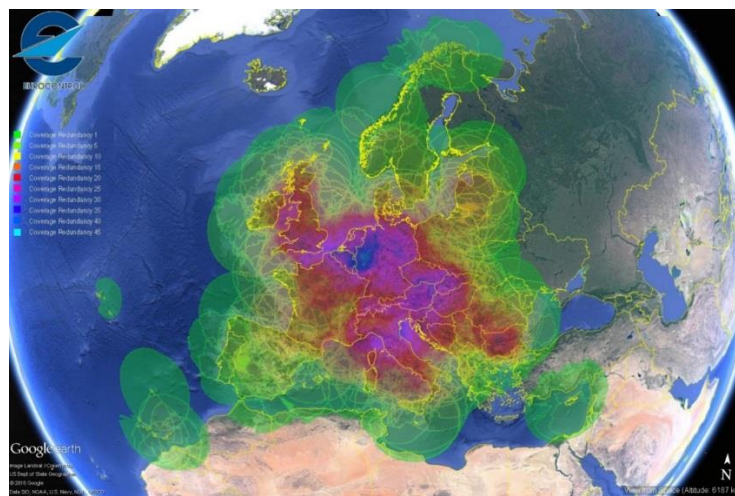


Figure 10 – Independent cooperative Surveillance coverage

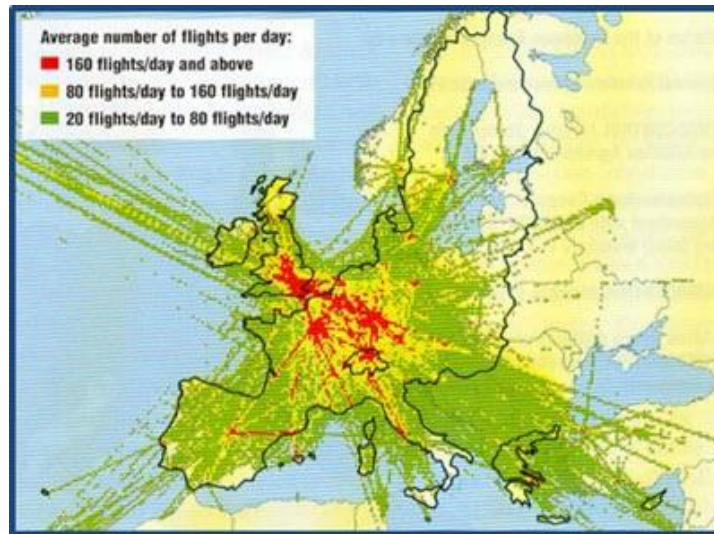


Figure 11 – European airspace density

3.3 Other considerations

Regarding the referencing to ICAO provisions in regulations, both the ‘Basic Regulation’ and the SES regulations require that any implementing regulation should assist Member States in fulfilling their obligations under the Chicago Convention, by providing a basis for a common interpretation and uniform application of its provisions. As a consequence the members States request that implementing regulations should always be referencing the latest amendment. Ensuring appropriate compliance with ICAO needs to be maintained.

Changing operational environments requires an evolution in the communication, navigation and surveillance (CNS) infrastructure that is being defined as part of ATM Master Plan. Such changes will necessitate changes to both aircraft and ground systems that need to be accomplished in a coordinated and harmonised manner in order to ensure safety and the effectiveness of the European airspace that will provide benefits to all stakeholders and to enable the high level Single European Sky (SES) objectives to be met. The Agency is in the process of establishing a CNS implementation support task that proposes EASA actions to be integrated into the European Plan for Aviation Safety (EPAS) to prepare the required regulatory, promotion and supporting material and actions to ensure the effective implementation of an improved CNS infrastructure and the associated operational improvements. This task will address all aspects of CNS operations for Europe in a coherent manner, so that the CNS domains are consistent with each other. In this aspect the use of Surveillance technologies, in particular ADS-B, needs to be addressed in conjunction the planned Navigation



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applications. Thus major changes to any surveillance implementation requirements at this stage may be detrimental to the overall CNS performance.

As already indicated in paragraph 1 there is general agreement in support of a European ground and aircraft mandate, it is also recognised that an evolution of the CNS infrastructure is required in order to enable an efficient ATM system. Therefore appropriate regulatory and supporting measures are needed to initiate this evolution.

Furthermore, the Commission has requested that the SJU to prepare a proposal for a new Common Project (CP2), (based on Regulation (EU) No 409/2013³⁷). The CP2 proposal is required to address CNS rationalisation in order to maximise benefits, whilst recognising decommissioning and change management costs. Once again any major changes to any surveillance implementation requirements at this stage may be detrimental to the overall CNS performance.

4 EASA regulatory proposal

Based on the above the following regulatory proposals are possible:

- A. 'Minor' amendment to the existing regulations to
- a. introduce an exemption to permit non-compliant aircraft deliveries and operations of non-compliant aircraft under specific conditions,
 - b. amend the ICAO reference to amendment 77 of Annex 10 enabling the continued operation of aircraft already equipped with suitable transponders
 - c. alleviate the retrofit requirements
 - d. to address the issue of state aircraft conspicuity through the use of Mode A only.
 - e. amend the ICAO reference to amendment 85 of Annex 10 in regulation 2017/373 enabling the continued safe and efficient operation of the ground surveillance systems
- plus

³⁷ COMMISSION IMPLEMENTING REGULATION (EU) No 409/2013 of 3 May 2013 on the definition of common projects, the establishment of governance and the identification of incentives supporting the implementation of the European Air Traffic Management Master Plan (OJ L 123, 4.5.2013, p. 1).



recognising the need to initiate the transformation of the surveillance infrastructure to a more efficient system and as the increased use of ADS-B is foreseen in the ATM Master Plan, and as envisaged as part of the CNS evolution, require the use of ADS-B data in the ground surveillance system.

and

either as part of the envisaged CNS implementation support task or through a dedicated task to continue to establish to EASA actions required to further develop the appropriate regulatory, promotional and supporting material³⁸ to address the harmonised use of ADS-B technology within European Airspace.

Or

- B. An amendment to Commission Regulation 2017/xxx laying down implementing rules for common airspace usage requirements and operating procedures, Commission Implementing Regulation (EU) 2017/373, Commission Implementing Regulation (EU) 923/2012 and repeal of Commission Implementing Regulation (EU) No 1207/2011, 1206/2011, and Commission Regulation (EC) No 262/2009, for the full use of ADS-B by the ground system for IFR operation in controlled airspace including the equipage of all aircraft operation in airspace classes A,B,C,D and E with ELS/EHS and ADS-B, as shown in Figure 12 below.

³⁸ The appropriate regulatory, promotional and supporting material will be developed in accordance with Agency normal procedures and referenced in the European Plan for Aviation Safety (EPAS)



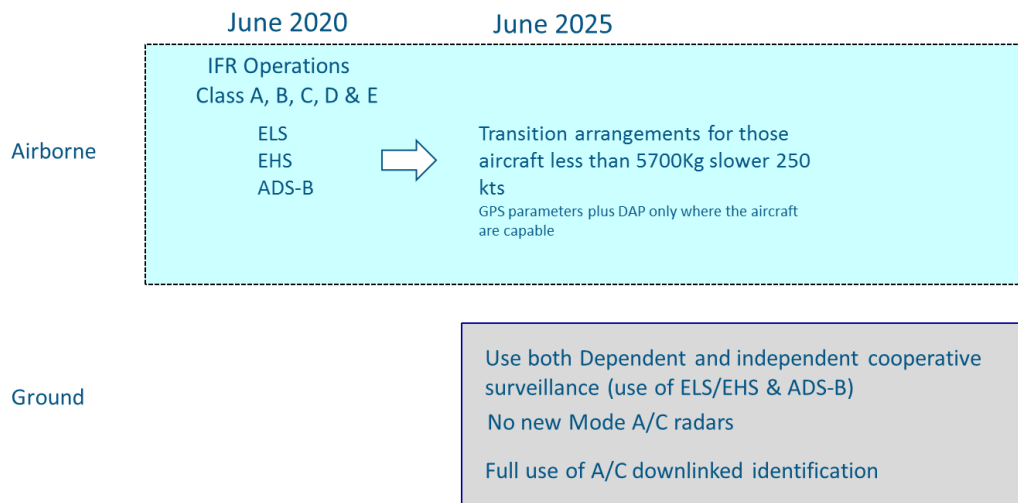


Figure 5 – 2nd regulatory proposal

4.1 Preferred option

Noting that:

- a significant amount of work is still required to ensure harmonised and effective European operations supported by an appropriate surveillance system that is fit for all airspace users;
- no operational benefits in terms better routings or separation minima that improve the efficiency of operations are evident from equipping the European ATM system (aircraft and ground) with ADS-B;
- no immediate safety issues has been identified;
- the evolution to an efficient ATM system needs to be initiated;
- the operational use of aircraft identification needs to be maintained as required by Regulation 1206/2011 via the carriage of Mode S (ELS) as a minimum.



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The **preferred option is Option A**, minor amendment to the existing regulations (Regulation (EU) No 1207/2011 1206/2011 and 2017/373); plus the CNS implementation support work that is under preparation and the subsequent establishment of a work programme to identify the appropriate integration of all airspace user and to prepare the regulatory, promotion and supporting material, as required. Furthermore as it is recognised that the currently effected stakeholders require additional guidance material to support a harmonised implementation of the amended SPI regulation as proposed, EASA intends to publish these addition Guidelines.

In adopting this option the European regulations will not be compliant with the ICAO Annex 10 volume IV and therefore necessitate a difference to be filed with ICAO. A draft text of such a difference is shown in Annex II.

It should also be noted that in adopting this proposal no changes to the published provision of CS-ACNS, will be required. The published provisions will be applicable for new design and will ensure a transition to ICAO SARP compliance.

4.2 Description of the changes to Regulation (EU) No 1207/2011

The following sections focuses only on the most relevant changes proposals. Additional minor amendments are also to be proposed to clarify the text. A proposed amending regulation is detailed in Annex I which shows all the proposed regulatory changes.

4.2.1 Aircraft whose avionics exhibit a functional anomaly

Both Art. 4(4) and Art 7(2) deal with aircraft whose avionics exhibit a functional anomaly. The wording of these two requirements have been redistributed, so that Art 4(4) focuses on ANSPs' responsibilities, while Art 7(2) reflects operators'.

In addition, Art 4(4) now incorporates a deadline of 24 hours to inform the operator of the anomaly observed once confirmed.



The provision about the need for the operator to investigate and repair the issue detected with the faulty avionics has been deleted from both articles, as there was a clear duplication and, most importantly, this regulation is not considered the right place to address this particular subject. It should be noted that current Air-OPS and continuing airworthiness requirements already prescribe what should be done in case an anomaly is detected, i.e. the aircraft could continue to operate provided that the MEL allows this possibility, otherwise the aircraft must stay on the ground and go through maintenance.

4.2.2 Use of individual aircraft Identification by the ANSPs and related exemptions

Art 5(3) addresses the uptake of the aircraft ID by the ANSP by 2 January 2020. This requirement clearly duplicates Art 4(2) of the 'ACID Regulation', where the use of this feature is extensively regulated; for that reason, deletion from the 'SPI Regulation' is proposed.

The same is valid for Art. 13, which deals with exemptions that could be granted to the military due to procurement constraints that hinder compliance with Art. 5(3). These requirements are replicated in Art. 11 of the 'ACID Regulation' as well, so deletion from the 'SPI Regulation' is proposed for the same reason.

4.2.3 Ground system mandate

A new Art 5(3) has been incorporated into Art 5 that requires Air navigation service providers to integrate and use ADS-B data transmitted from an aircraft into the ground surveillance system as of 31 December 2025. This date is co-incident with the date that the aircraft need to complete all retrofit actions.

4.2.4 The aircraft mandate and related exemptions

An addition has been incorporated in point (c) of Art. 5(5) to align the wording with Art. 8(2) and make clear that ADS-B capabilities are required for operations of certain fixed-wing aircraft.

The continuity requirement considered in Part A and Part B of Annex II is proposed to be deleted, since there is no of safety issues linked to lack of continuity of transponder transmissions. However, a general objective regarding continuity has been introduced such that it shall not impose a risk to the airspace operations.

As regards exemptions, several modifications are proposed in Art. 14:

- Point 2 is amended so that the applicable aircraft are automatically exempted from conforming to the antenna diversity requirement as opposed to 'may be'.



- Point 3, 4 and 5 are deleted, as the criteria to grant exemptions are certainly ambiguous and considers a wording that is similar to that contained in Regulation (EC) No 29/2009, which has been recently revised to address the difficulties associated with the interpretation of the exemption requirements.

Some new exemption requirements are introduced to replace those 3 paragraphs deleted from the regulation as follows:

- New Point 3 exempts older aircraft from the necessity of complying with the ADS-B and EHS provisions, i.e. those aircraft with a certificate of airworthiness first issued before 31 December 1995.
- New point 4 addresses the process to grant exemptions on aircraft with regard to the ADS-B and EHS capabilities. Two different options are provided for consideration. The first option permits the MS who are responsible for the operational approval of European Operators to issue exemptions of a limited duration without prior coordination or agreement of other MS or EU institutions. This ensures that the oversight of a European operator is fully with the remit of MS but does not address the issues associated to possible exemption requests from Non-European (third country) operators. The second option, provides for a centralised handling of all exemption requests, including Non-European (third country) operators. This approach will enable EASA to have a complete picture of the exemptions and associated risks with respect to operations with European airspace.
- New point 5 and 6 exempts maintenance, delivery and test flights from conforming to the ADS-B and EHS requirements, provided that these aircraft are equipped with a serviceable ELS transponder, which is considered the minimum capability to operate in the MS area. In addition, aircraft equipped with faulty transponders can continue to operate for a period of 3 days at the most.

A new article 16 is proposed to provide for transitional and temporary equipage requirements such as:

- A temporary exemption from the requirements of Article 5(5) for retrofit to align with the date by which the ANSP's should commence to use ADS-B position data.

4.2.5 Revision of ICAO references

Some requirements have been revised to refer to the latest ICAO amendment, i.e. Art 5(6), Art 6(2) and Art. 7(3), which address operation with antenna diversity, the assignment of the 24-bit ICAO address and the minimum reply rate capabilities, respectively, these revised references do not impact already certified aircraft.



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However, the most relevant change has been introduced in Annex II to the regulation, where Amendment 77 to ICAO Annex 10 is now proposed as the minimum standard for secondary surveillance transponders. If adopted, this would allow to sort out the technical issues described in Section 2.1 and Section 3.1, thus permitting operation of the vast majority of aircraft currently equipped with a Mode S transponder.

4.2.6 Deadline for non-equipage of State aircraft

Paragraph (b) of Art. 8(3) has been amended to extend the deadline by which a State aircraft can continue to operate without conforming to the equipage requirements and align this date with that proposed for civil operations, i.e. 31 December 2025.

4.2.7 Deletion of requirements currently addressed in other regulations

With regard to changes to functional systems, Art 9(2) and Art.9(3) do not add any value with respect to equivalent requirements in Regulation (EU) No 1034/2011³⁹ and Regulation (EU) No 1035/2011⁴⁰ nor Regulation No (EU) 2017/373, which currently regulate under what circumstances a safety assessment must be conducted and how. Therefore, deletion is proposed, together with Annex VI.

The same goes for requirements contemplated in Article 12, which addresses a number of topics that are duly covered under Regulation (EU) No 1035/2011 and Regulation No (EU) 2017/373, i.e. competence and training of providers' personnel, manuals of operations and the publication of information in the national AIPs, which is a responsibility allocated to the AIS providers, as per the referred to regulation. Also, obligations regarding the operation and maintenance of airborne surveillance systems are currently addressed by Air-OPS and continuing airworthiness requirements.

³⁹ COMMISSION IMPLEMENTING REGULATION (EU) No 1034/2011 of 17 October 2011 on safety oversight in air traffic management and air navigation services and amending Regulation (EU) No 691/2010 (OJ L 271, 18.10.2011, p. 15).

⁴⁰ COMMISSION IMPLEMENTING REGULATION (EU) No 1035/2011 of 17 October 2011 laying down common requirements for the provision of air navigation services and amending Regulations (EC) No 482/2008 and (EU) No 691/2010 (OJ L 271, 18.10.2011, p. 23).



4.3 Description of the changes to Regulation (EU) No 1206/2011

The following sections focus only on the most relevant changes proposals. Additional minor amendments are also to be proposed to clarify the text. A proposed amending regulation is detailed in Annex I which shows all the proposed regulatory changes.

4.3.1 Deletion of requirements currently addressed in other regulations

As in the previous case⁴¹, the 'ACID Regulation' also lays down requirements that are specifically developed in other EU regulations.

Art. 5 represents a clear duplication of rules to address safety assessment to changes to functional systems, so its deletion is proposed together with Annex VI.

And the same goes for Art. 8, where requirements that deal with training and competence of ANS providers' staff or those related to the contents and access to suitable manuals of operations could also be deleted, as they are redundant.

Also, obligations regarding the operation and maintenance of transponders are currently addressed by Air-OPS (including TCO) and continuing airworthiness requirements, so Art. 9(1) could be deleted.

Similarly, Art. 9(2) is also dispensable as Annex II to the 'SPI Regulation' regulates the availability of downlinked aircraft parameters, including the aircraft identification function. To ensure consistency, Art. 9(4) replaces its reference to this paragraph by another one to the 'SPI Regulation'.

Finally, Art.10 is a duplication, as the publication of information in the national AIPs is currently a responsibility allocated to the AIS providers and specifically addressed in the 'Common Requirements Regulation'⁴².

⁴¹ See Section 4.2.6 for more information on EU regulations that address the subjects presented in this section.

⁴² Regulation (EU) No 1035/2011.



4.3.2 Rule exemptions

The requirements by which military ANSPs would be allowed to delay the implementation of the capability to use the downlinked aircraft identification, i.e. Art. 11, has been amended so as to extend the deadline to communicate exemptions until 1 January 2019 (1 more year). Also, the evaluation is made compulsory rather than a possibility, although the deadline to review the exemptions granted by the MS is extended by two years.

4.3.3 Confidentiality/Security issues

As explained in Section 2.1, State aircraft operators have repeatedly expressed their concerns about real-time tracking of their aircraft by organisations that do not provide Air Navigation services and could hide malicious intentions. Instead of transmitting the aircraft identification they propose switching to Mode 3/A and transmitting discreet SSR Codes.

Paragraph 3 of Annex II lists those cases in which SSR codes can be used for the purpose of individual aircraft identification; State aircraft engaged in VIP Transport and aircraft undertaking police and custom operations have been added to the list, so as to satisfy these operators' demands.



Appendix 1: CBA data

1) Estimated CS25 fleet equipped in 2016 with ADS-B

The EASA MS Commercial Fleet greater than 5 700 kg MTOW and the compliance status with SPI IR based on the survey in 2016 is shown in Table 1-1

<i>Commercial fleet status from EASA Survey</i>				
Current configuration	Current compliance with SPI IR			Grand Total
	No	Yes	No information	
ADS-B	104	10		114 ⁴³
ADS-B, EHS, ELS	360	205		565
ADS-B, ELS	18	13		31
EHS, ELS	433	280	154	867
ELS	7	74		81
ELS, Mode A/C		11		11
No information		4	3	7
Grand Total	922	597	157	1 676
Fleet equipped with ADS-B and SPI IR compliant				228 ⁴⁴
				14%
<i>Fleet estimates at EASA MS level</i>				
Total EASA MS fleet in 2017 (Commercial operators)				7313
Estimated total current fleet with ADS-B and SPI IR compliant (<i>based on 15%</i>)				995
Estimated new fleet in 2018 & 2019 before SPI IR deadline (2020)*				1 002
Estimated fleet for ADS-B retrofit				5 316
Number of months before SPI IR deadline				35
Estimated number of retrofit aircraft per month				152

Table 1-1 - EASA MS Commercial Fleet > 5 700 kg MTOW compliant with SPI IR based on the survey in 2016

* Replacement: 588 a/c phased out in 2018+2019 and replaced by new ones and new a/c due to business growth: (+ 2.7% increase in fleet per year: 414)

⁴³ The respondents only indicated “ADS-B” when in reality there is necessarily also another transponder functionality installed on the aircraft to comply with existing requirements.

⁴⁴ 228 = 10 + 205 + 13 from the column “Current compliance with SPI IR: Yes”



There appears to be an industrial capacity issue to support this fleet will be compliance with the SPI IR by 2020.

2) Current surveillance infrastructure costs

a) Civil ground surveillance costs (€)

The estimates for the total financial value of the civil ground surveillance infrastructure in EASA MS in 2017 based on the EASA survey are shown in Table 1-2.

Type of sensor	Number of sensors	One-off costs per sensor (€)	Total one-off costs (€)	Operational costs per sensor (€)	Life-time	Total operational costs	Total life-cycle costs (LCC)	Global life cycle cost per year (€)	LCC per type of sensor and per year (€)
PSR stand-alone	31	3 737 386	115 858 976	221 615	23	158 011 495	273 870 471	11 907 412	384 110
PSR with Mode A/C	45	2 681 307	120 658 808	221 615	21	209 426 175	330 084 983	15 718 333	349 296
PSR with Mode S	93	2 681 307	249 361 536	221 615	21	432 814 095	682 175 631	32 484 554	349 296
Mode AC	137	1 580 960	216 591 520	169 943	21	488 926 011	705 517 531	33 596 073	245 227
Mode S	210	1 868 693	392 425 564	178 965	20	751 653 000	1 144 078 564	57 203 928	272 400
ADS-B	74	75 500	5 587 000	40 562	15	45 023 820	50 610 820	3 374 055	45 595
WAM	776	119 853	93 005 928	15 731	15	183 108 840	276 114 768	18 407 651	23 721
Total	1 366		1 193 489 332			2 268 963 436	3 462 452 768	172 692 005	
Total related to PSR			485 879 320			800 251 765	1 286 131 085		
Total related to Mode A/C and Mode S			609 017 084			1 240 579 011	1 849 596 095		
Total related to ADS-B & WAM			98 592 928			228 132 660	326 725 588		
Relative share									
PSR			41%			35%	37%		
Mode A/C + Mode S			51%			55%	53%		
ADS-B & WAM			8%			10%	9%		

Source: EASA Survey 2016

Table 1-2 - Estimates for the total financial value of the civil ground surveillance infrastructure in EASA Member States - Situation in 2017 (Source: EASA survey)

Notes: - one-off costs for PSR with Mode A/C or Mode S are based on 4 500 000€ for the complete package PSR+Mode S minus Mode S radar cost;
- cost related to Space-Based ADS-B is not estimated due to lack of information;
- Mode A/C and Mode S figures includes the related radars indicated in "PSR with Mode A/C" and "PSR with Mode S"



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b) Surveillance in the en-route charges and airspace user expectations

According to the Performance Review Board⁴⁵ (PRB) information, it is estimated that surveillance equipment account for 5% of the en-route charges, forecasted at 405M€ in 2017⁴⁶ as shown in Table 1-3.

<i>Scope: EASA MS</i>	<i>Million Euro</i>
ANSPs global revenues	8019
ANSPs surveillance costs	405
<i>Relative share</i>	<i>5%</i>

Table 1-3 – PRB Surveillance costs

Reminder from the previous section 2)a):

- The annual life cycle costs estimated for surveillance infrastructure are approximately 170 M€, half of the surveillance costs from PRB information ;
- About 50% of these 170M€ are related to Secondary Surveillance Radars (SSR) equipment.

The PRB surveillance costs may consider items other than the ones in the scope of the EASA survey. At this stage of the analysis, it was not possible to get further details.

Conclusion on airspace user expectation regarding en-route charges

Airspace users consider that the ground cost inefficiency in the current situation results in higher user charges (e.g. en-route charges).

Airspace users expect that surveillance rationalisation through the implementation of ADS-B and the partial removal of SSR (problem tree analysis) will decrease the route charges. Even in the case that further SSR rationalisation with ADS-B could decrease the share of SSR in the total surveillance costs, it would take a long time to achieve a significant reduction of the related route charges. However, from the data above, en-route charges are in fact slightly impacted by surveillance equipment costs (5% overall).

As a consequence airspace users may have too high expectations regarding future route charges decrease based on SSR rationalisation.

⁴⁵ https://webgate.ec.europa.eu/eusinglesky/content/welcome_en

⁴⁶ Forecast for 2017 based on information from the Enlarged Committee for Route Charges report from 2015 (CER-105-2015-3552, ITEM 2, 10.12.15)



3) Implementation Cost analysis

a) ADS-B cost impact for 'CS25' fleet

The unit costs are shown in Table 1-4, these unit cost have been applied to the large aircraft and BA that are in the scope of the SPI IR (source for the fleet data is the ASCEND database) as are shown in Table 1-5

	SPI IR / estimated cost in USD for	
	"new aircraft" , i.e. delivered after year 2000, (e.g. CRJ700/900, E170/190, A320fam, 737NG, 787, newer A330, B777-300ER, 747-8, A380, ...)	"old aircraft", i.e. delivered before year 2000 (e.g. 737-300, B767, 747-400, MD11, early A320fam without MMR, 777, A340, ...)
Transponder (2 units) software and/or hardware upgrade	\$25.000	\$25.000
or	or	Or
Transponder (2 units) replacement (if existing one is not upgradeable to DO 260B standard)	\$70.000	\$70.000
Installation of GNSS (install MMR)	\$0 (GPS already installed)	0 - \$250.000 (\$0 if GPS already installed)
or	or	Or
Installation of GPSSU (STC)		\$0 - \$100.000 (\$0 if GPS already installed)
ADS-B fail indication (into TCAS control panel)	\$30.000	\$30.000
or	or	Or
ADS-B fail indication (into EFIS)	\$10.000 - \$40.000	\$10.000 - \$80.000
a/c without wiring (e.g. GPS source to transponder (need to install the wire)	\$10.000	\$10.000
Airframer Service Bulletin for ADS-B out (SPI IR) certification package	\$5.000 - \$10.000	\$50.000 - \$100.000
Total estimated unit costs in USD	\$50.000 - \$130.000	\$85.000 - \$500.000⁴⁷
Total estimated unit costs in EUR	€45 500 - €118 300	€77.350 - €455.000

Important Remarks

All transport aircraft delivered from 2017 are compliant already from production (0€ to be accounted for the SPI IR mandate)

Nearly all European long range aircraft will be compliant by Jan. 1st, 2020 due to the FAA mandate, which is compatible with the SPI IR compliant configuration (0€ to be accounted for the SPI IR mandate)

Table 1-4 - ADS-B transponder unit cost for large aircraft and BA fleet in the scope of SPI IR



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Indicator	Year group	Low / high range	2010	2017	2018	2019	2020	2021	2022	2023	2024
Total EASA MS Operator fleet			6 038	7 313	7 513	7 713	7 933	8 153	8 373	8 593	8 813
	New aircraft fleet from 2017		N/A	366	605	1 210	1 542	1 874	2 205	2 537	3 235
	Existing fleet from 2000 to 2017 and remaining at least operational up to 2024		3 308	5 187	5 187	5 187	5 187	5 187	5 187	5 187	5 187
	Fleet before 2000		2 730	1 760	1 355	950	838	726	615	503	391
	<i>Share of the total fleet impacted by the FAA mandate: 20% of the European operators fleet</i>	20%	1 208	1 463	1 503	1 543	1 587	1 631	1 675	1 719	1 763
Total fleet cost (Million €)											
		low	800	372	341	310	301	292	284	275	266
		high	1 653	1 414	1 230	1 046	995	944	893	842	792
	New aircraft fleet from 2017		0	0	0	0	0	0	0	0	0
	Existing fleet from 2000 to 2017	low	124	236	236	236	236	236	236	236	236
		high	323	614	614	614	614	614	614	614	614
	Fleet before 2000	low	676	136	105	73	65	56	48	39	30
		high	1 331	801	617	432	381	331	280	229	178
	<i>Fleet costs impacted by the FAA mandate: 20% of the European operators fleet</i>	low	160	74	68	62	60	58	57	55	53
		high	331	283	246	209	199				



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Unit cost (€)	New aircraft fleet from 2017		N/A	0	0	0	0	0	0	0	0
	Existing fleet from 2000 to 2017	low	37 500	45 500	45 500	45 500	45 500	45 500	45 500	45 500	45 500
		high	97 500	118 300	118 300	118 300	118 300	118 300	118 300	118 300	118 300
	Fleet before 2000	low	247 500	77 350	77 350	77 350	77 350	77 350	77 350	77 350	77 350
		high	487 500	455 000	455 000	455 000	455 000	455 000	455 000	455 000	455 000
	Exchange rate EUR-USD			0.75	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Unit cost (\$)	New aircraft fleet from 2017		N/A	0	0	0	0	0	0	0	0
	Existing fleet from 2000 to 2017	low	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
		high	130 000	130 000	130 000	130 000	130 000	130 000	130 000	130 000	130 000
	Fleet before 2000	low	330 000	85 000	85 000	85 000	85 000	85 000	85 000	85 000	85 000
		high	650 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000	500 000

Source: EASA Survey 2016

Table 1-5 – Estimated CS-25 fleet cost impact for EASA MS Operators with ADS-B requirements from SPI IR



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b) ADS-B cost impact for GA fleet

The cost impact to equip the 'GA fleet flying in class E or above would be impacted by 350 M€ in 2017, based the following estimated unit cost for ADS-B transponder purchase and installation:

- 926€ for new aircraft (500\$ for purchase, same amount for installation)
- 5 556€ for retrofit (3 000\$ for purchase, same amount for installation)
(source: GAMA and RMG)

	Share of aircraft flying in Class E or above	Fleet number		Cost impact for VFR			Cost impact for IFR			Whole GA fleet		
		VFR	IFR	Total	New a/c	Retrofit	Total	New a/c	Retrofit	Total	New a/c	Retrofit
GA FW VFR	100%	27 000	18 000	138	3	135	92	2	90	229	4	225
GA Rotorcraft	100%	4 200	2 800	21	0	21	14	0	14	36	1	35
Sailplanes	50%	25 000	0	64	1	63	0	0	0	64	1	63
Microlight	30%	20 000	0	19	3	17	0	0	0	19	3	17
Balloons	0%	6 000	0	0	0	0	0	0	0	0	0	0
Gyroplanes	0%	1 000	0	0	0	0	0	0	0	0	0	0
Total		83 200	20 800	242	7	235	106	2	104	348	9	339

Source: EASA Survey 2016

Table 1-6 - ADS-B cost impact for GA fleet by 2027 (Option 1)



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c) ADS-B cost impact for helicopter operators

As for the CS25 aeroplane fleet above, the analysis is limited to the civil helicopter (military and state helicopter are not included).

The helicopter fleet above 5.7t MTOW is in the scope of the current SPI IR. The estimated investment cost would be approximately 30M€ by 2020.

The helicopter fleet below 5.7t MTOW needs to be considered in the analysis of Option 1 which consider all airspace users. The fleet cost impact for the helicopter operators would be approximately 750 M€ by 2027.

Scope: EASA MS Operators		Fleet in 2016	Fleet cost in € for ADS-B	
MTOW in kg	Aircraft Age	Civil	Unit cost	Total
0-5699	> 2000	2 944	20 000	58 880 000
	< 2000	2 197	50 000	109 850 000
	Total	5 141		168 730 000
>5699	> 2000	193	70 000	13 510 000
	< 2000	59	250 000	14 750 000
	Total	252		28 260 000
Grand Total		5 393		196 990 000

Sources:

- *Fleet: ASCEND*
- *Unit cost: EASA estimates with the support of helicopter industry (confidential information)*

Table 1-7 - ADS-B cost impact for helicopter fleet



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d) ADS-B cost impact for ANPS

The cost impact on ANSPs would be 220 M€ from 2025 to 2039, as shown in Table 1-8. This is associated with the investment and operating costs for ADS-B sensors, after assuming that 2 ADS-B stations are equivalent to an SSR in those areas where there is no country-wide WAM or space-based ADS-B implementation or a sufficient combination of WAM sensors and ADS-B stations.

This assumption was the only one accepted by the RMG due to lack of consensus on how to implement ADS-B on the ground. As a consequence, this assumption will be subject to significant variation when it will be compared to the real ADS-B implementation.

The following estimated basic data has been used for ADS-B ground station implementation:

CAPEX per station	75 000	Euro
OPEX per station and per year	40 000	Euro/year
Lifetime	15	Years
Total OPEX over lifetime	600 000	Euro
Total Life Cycle Cost per station	675 000	Euro



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< Revision of the SPI Regulation >

EASA MS	Estimated situation in 2025					Estimated situation with the Option 1						
EASA MS	Mode AC	Mode S	Total SSR	WAM	ADS-B	New ADS-B stations SPI IR	Upper range of new ADS-B stations estimates ⁴⁸	CAPEX (€)	Annual OPEX (€)	OPEX over 15 years (€)	ADS-B cost integration in RDPS	Total costs (€)
AUT	1	3	4	68			0	0	0	0	0	0
BEL	2	6	8			16	16	1 200 000	640 000	9 600 000	0	10 800 000
BGR	3	3	6	58				0	0	0	0	0
CHE		7	7	50		0	0	0	0	0	0	0
CYP	1	3	4		3	Space based			0	0	0	0
CZE		3	3	28	3			0	0	0	0	0
DEU	15	15	30	34	5	60	55	4 125 000	2 200 000	33 000 000	650 000	37 775 000
DNK	4	1	5	30	22			0	0	0	0	0
ESP	10	17	27	8	3	54	51	3 825 000	2 040 000	30 600 000	0	34 425 000
EST			0	24							0	0
FIN	6		6	154			0	0	0	0	0	0
FRA		28	28	88	26	56	30	2 250 000	1 200 000	18 000 000	0	20 250 000

⁴⁸ = column [New ADS-B stations SPI IR] – column [ADS-B]. This formula is not applicable for the following cases: CYP, CZE, DNK, ITA, NOR and PRT because the number of WAM and/or ADS-B stations or the foreseen implementation of satellite ADS-B is sufficient to ensure the necessary coverage



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< Revision of the SPI Regulation >

EASA MS	Estimated situation in 2025					Estimated situation with the Option 1						
EASA MS	Mode AC	Mode S	Total SSR	WAM	ADS-B	New ADS-B stations SPI IR	Upper range of new ADS-B stations estimates ⁴⁸	CAPEX (€)	Annual OPEX (€)	OPEX over 15 years (€)	ADS-B cost integration in RDPS	Total costs (€)
GBR		43	43	25		86	86	6 450 000	3 440 000	51 600 000	0	58 050 000
GRC	9		9	6	14	18	4	300 000	160 000	2 400 000	0	2 700 000
HRV		4	4			8	8	600 000	320 000	4 800 000	0	5 400 000
HUN		4	4			8	8	600 000	320 000	4 800 000	0	5 400 000
IRL	2	6	8			16	16	1 200 000	640 000	9 600 000	0	10 800 000
ISL	6		6		8	12	4	300 000	160 000	2 400 000	0	2 700 000
ITA	2	26	28		16	Space based			0	0	0	0
LTU		3	3			6	6	450 000	240 000	3 600 000	0	4 050 000
LUX		1	1			2	2	150 000	80 000	1 200 000	0	1 350 000
LVA		3	3			6	6	450 000	240 000	3 600 000	0	4 050 000
MLT	4	2	6			12	12	900 000	480 000	7 200 000	0	8 100 000
NLD		2	2	55		4	4	300 000	160 000	2 400 000	0	2 700 000
NOR	4	8	12	72	15			0	0	0	0	0
POL	5	4	9	48						0	0	0
PRT	2	7	9	82	1			0	0	0	0	0
ROU	2	6	8	37			0	0	0	0	0	0
SVK		4	4		1	8	7	525 000	280 000	4 200 000	0	4 725 000
SVN	1	3	4		1	8	7	525 000	280 000	4 200 000	0	4 725 000
SWE	11	6	17	61			0	0	0	0	0	0



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< Revision of the SPI Regulation >

EASA MS	Estimated situation in 2025					Estimated situation with the Option 1						
	Number of sensors					New ADS- B stations SPI IR	Upper range of new ADS- B stations estimates ⁴⁸	CAPEX (€)	Annual OPEX (€)	OPEX over 15 years (€)	ADS-B cost integration in RDPS	Total costs (€)
EASA MS	Mode AC	Mode S	Total I SSR	WAM	ADS- B							
Total	90	218	308	928	118	380	322	24 150 000	12 880 000	193 200 000	650 000	218 000 000

Table 1-8 –ADS-B cost impact for ANPS

Notes:

- Source: EASA Survey 2016
- NLD: LVNL will assess the opportunity to implement a WAM system for the whole country in 2017. LVNL is using also 6 military Mode S.
- GRC: FRAPORT had invested for 14 ADS-B stations in Greek Islands
- CAPEX: one-off cost
- OPEX: operational costs, telecommunication cost, site rental, ...



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4) Assumption for surveillance rationalisation above FL180

The assumptions that support the amount of rationalisation used in the analysis are a result of a theoretical study (see Annex III). It should be recognised that, as this is a theoretical study, the actual amount of rationalisation is likely to be less than that presented.

Caveats:

- *Section 4.1.1 Surveillance data provided by EASA: this report was based on data provided by EASA in March 2017 to ALG-ALPAC. Since that date, there were updated information received by EASA that are not integrated in the ALG-APAC report. These updates only impact marginally the total number of ground surveillance infrastructure. As a consequence, there are some slight differences between the ALG-APAC report and the last updated information presented in other sections of the EASA report.*
- *Section 4.1.3 Surveillance data included in the analysis: the data refer only to ground surveillance when the “Standardised usage” field is “En-route” or “APP/En-route” (based on the EASA Survey).*



Annex I:**Proposed draft implementing regulation****COMMISSION IMPLEMENTING REGULATION (EU) .../..****of XXX****amending Commission Implementing Regulation (EU) No 1207/2011, 1206/2011, and 2017/373**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation) (1), and in particular Article 3(5) thereof.

Having regard to Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC⁽⁴⁹⁾, and in particular Article 8b(6) thereof,

Whereas:

⁴⁹ OJ L 79, 13.3.2008, p. 1.



- (1) In order to ensure the safe and efficient operations of aircraft, aerodromes, air traffic management, and air navigation and of the European air traffic management network, it is necessary to implement certain operational improvements. Safety requirements and associated interoperability requirements should therefore be imposed on operators of aircraft registered in a Member State or registered in a third country and used by an operator for which a Member State ensure oversight of operations, or by a third country operator within the Union, as well as on aerodrome operators, air navigation service providers and the Network Manager.
- (2) Commission Implementing Regulation (EU) No 1207/2011 lays down 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 those systems within the European air traffic management network and for the purpose of civil-military coordination.
- (3) Commission Implementing Regulation (EU) No 1206/2011 lays down requirements for the systems contributing to the provision of surveillance information, their constituents and associated procedures in order to ensure the unambiguous and continuous individual identification of aircraft within the European air traffic management network.
- (4) Commission Implementing Regulation (EU) No 2017/373 lays down the provision of air traffic management and air navigation services ('ATM/ANS') and other air traffic management network functions ('ATM network functions'), the certification, oversight and enforcement tasks thereof, for general air traffic, in particular ANNEX VIII Part-CNS.
- (5) Stakeholders have reported that, currently, equipped airborne constituents of the surveillance systems are not always compliant with Implementing Regulation (EU) No 1207/2011. This applies especially to previously deployed Mode S Elementary transponders which appear not to comply with the most recent standard (ED-73E) as provided in the relevant certification specifications of the Agency. The non-compliant transponders are fully compatible with the foreseen surveillance systems.
- (6) Furthermore, a review by the European Aviation Safety Agency revealed that it was not evident that the anticipated benefits that could be expect from the implementation of a potential rationalised infrastructure though the use of ADS-B could be achieved. Also no operational benefits were evident, on a pan-European basis, in terms of better routings or separation minima that improve the efficiency of operations, from equipping the European ATM system (aircraft and ground) with ADS-B. Although, ADS-B has potential benefits that are linked to future operation concepts and these currently cannot be quantified, there is a need to progress with ADS-B implementation.
- (7) Therefore, the dates and the technical standards to which operators and ANSP's are to comply with the relevant interoperability requirements of Implementing Regulation (EU) No 1207/2011 should be amended.
- (8) In order to ensure consistency, operators of State aircraft should benefit from similar postponements in implementation dates as operators of other aircraft. The dates by which Member States are to ensure that State aircraft are compliant with the relevant requirements of Implementing Regulation (EU) No 1207/2011 should therefore also be amended.
- (9) Military stakeholders reported security concerns with respect to public availability of surveillance data and the ability to track and display State Aircraft through the use of the aircraft identification



function as a risk to flight safety. Therefore the ability of the European ATM system to ensure that state aircraft are able to operate without the use of aircraft identification should be established and reflected in. Implementing Regulation (EU) No 1206/2011.

- (10) Additionally stakeholders reported that the existing ground surveillance systems are fully compatible with the foreseen operation objectives and requiring an upgrade of these systems to the latest ICAO provisions are not proportionate to the ensure safety and interoperability. Therefore the requirements of Implementing Regulation (EU) No 2017/373 should be amended, to provide implementation relief.
- (11) Implementing Regulation (EU) No 1207/2011, 1206/2011 and 2017/373 should therefore be amended accordingly,
- (12) The measures provided in this Regulation are in accordance with the opinion of the Committee established by Article 5 of Regulation (EC) No 549/2004 of the European Parliament and of the Council⁵⁰,

⁵⁰ Regulation (EC) No 549/2004 of the European Parliament and of the Council of 10 March 2004 laying down the framework for the creation of the single European sky (the framework Regulation) (OJ L 96, 31.3.2004, p. 1).



Article 1

Regulation (EU) No 1207/2011 is amended as follows:

1. Article 4, paragraph 4 is replaced by the following:
 4. If an air navigation service provider identifies an aircraft whose avionics exhibit a functional anomaly, they shall within 24 hours from the confirmation of the anomaly inform the operator of the flight of the anomaly observed.
2. Article 5, paragraph 3 is replaced by the following
 3. Air navigation service providers shall ensure, by 31 December 2025, that the surveillance systems integrates dependent cooperative surveillance data.
3. Article 5 paragraph 5 is replaced by the following
 5. Operators shall ensure that by 7 June 2020:
 - (a) aircraft operating flights referred to in Article 2(2) are equipped with a serviceable secondary surveillance radar transponders having the capabilities set out in Part A of Annex II and with a continuity sufficient not to present an operational risk;
 - (b) aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), are equipped with a serviceable secondary surveillance radar transponders having, in addition to the capabilities set out in Part A of Annex II, the capabilities set out in Part B of that Annex and with continuity sufficient not to present an operational risk;
 - (c) fixed wing aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), are equipped with a serviceable secondary surveillance radar transponders having, in addition to the capabilities set out in Part A and Part B of Annex II, the capabilities set out in Part C of that Annex and with continuity sufficient not to present an operational risk.
6. Operators shall ensure that aircraft equipped in accordance with paragraph 5 and having a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots operate with antenna diversity as prescribed in paragraph 3.1.2.10.4 of Annex 10 to the Chicago Convention, Volume IV, Third Edition, including all amendments up to No 77.
7. Member States may impose carriage requirements in accordance with point (b) of paragraph 5 to all aircraft operating flights referred to in Article 2(2) in areas where surveillance services using the surveillance data identified in Part B of Annex II are provided by air navigation service providers.



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8. Air navigation service providers shall ensure that, before putting into service the systems referred to in points (b), (c) and (d) of Article 2(1), they are implementing the most efficient deployment solutions taking into account the local operating environments, constraints and needs as well as airspace users capabilities.
4. Article 6 paragraph 2 is replaced by the following
 2. For the purpose of paragraph 1, the sum of such interrogations shall not cause the secondary surveillance radar transponder to exceed the rates of reply per second, excluding any squitter transmissions, specified in paragraph 3.1.1.7.9.1 for Mode A/C replies and in paragraph 3.1.2.10.3.7.3 for Mode S replies of Annex 10 to the Chicago Convention, Volume IV, Third Edition including all amendments up to No 77.
5. Article 7 paragraph 2 and 3 is replaced by the following
 2. Operators shall ensure that an aircraft check is performed at least every two years, and before next flight whenever an anomaly is detected or reported on a specific aircraft, so that the data items set out in point 3 of Part A of Annex II, in point 3 of Part B of Annex II and in point 2 of Part C of Annex II, as applicable, are correctly provided at the output of secondary surveillance radar transponders.
 3. Member States shall ensure that the assignment of 24-bit ICAO aircraft addresses to aircraft equipped with a Mode S transponder complies with Chapter 9 and its appendix of Annex 10 to the Chicago Convention, Volume III, and Second Edition including all amendments up to No 90.
6. Article 8 paragraph 3(b) is replaced by the following
 - (b) State aircraft operating in accordance with Article 2(2) that will be out of operational service by 31 December 2025
7. Article 9, paragraph 2 and 3 are deleted
8. Article 12 and 13 are deleted
9. Article 14 is replaced by the following
 1. Aircraft with a first certificate of airworthiness issued before 7 June 2020 that have a maximum take-off mass exceeding 5 700 kg or a maximum cruising true airspeed greater than 250 knots that do not have the complete set of parameters detailed in Part C of Annex II available on a digital bus on-board are exempted from complying with the requirements of point (c) of Article 5(5).
 2. Aircraft with a first certificate of airworthiness issued before 1 January 1990 that have a maximum take-off mass exceeding 5 700 kg or a maximum cruising true airspeed greater than 250 knots are exempted from complying with the requirements of Article 5(6).
 3. Aircraft with a first certificate of airworthiness issued before 31 December 1995 are exempted from complying with the requirements of point (b) and (c) of Article 5(5).



4. Member States may grant exemptions from complying with the requirements of point (b) and (c) of Article 5(5) in the event of unforeseen urgent operational circumstances or operational needs of a limited duration, provided the level of safety is not adversely affected. The European Aviation Safety Agency shall be notified of any such exemptions as soon as they become repetitive or where they are granted for period of more than two months.

The European Aviation Safety Agency shall assess the exemptions notified by a Member State and within one month of being notified thereof, shall issue a recommendation to the Commission on whether these exemptions comply with the objectives of this regulation. If an exemption does not comply with the objectives of this Regulation the Commission shall inform the Member State of the finding. The Member State concerned shall revoke the exemption.

[Or, alternatively]

4. Aircraft operators shall submit to the European Aviation Safety Agency a request for exemptions from the requirements of point (b) and (c) of Article 5(5) in the event of unforeseen urgent operational circumstances or operational needs of a limited duration. The request shall be in a form and manner established by the Agency.

5. Aircraft are exempt from point (b) and (c) of Article 5(5) for the purpose of maintenance, delivery or flight testing;

6. Where equipment required by point (b) and (c) of Article 5(5) is temporarily inoperative, aircraft shall be entitled to operate in the airspace referred to in Article 2(2) for a maximum of 3 consecutive days.

10. Add new Article 16 as follows

Article 16

Transition

1 By way of derogation from Article 5, point (b) and (c) of Article 5(5) shall apply from 31 December 2025 for aircraft with a first certificate of airworthiness issued before 7 June 2020,

11. ANNEX II is amended as follows;

(a) Point 1 of Part A replaced by the following

1. The minimum capability for the secondary surveillance transponder shall be Mode S Level 2 meeting the performance and functionality objectives of Annex 10 to the Chicago Convention, Volume IV, Third Edition including all amendments up to No 77.

(b) Point 5 of Part A replaced by the following

5. The data items referred to in point 4 shall only be transmitted by the transponder via the Mode S protocol. The aircraft and equipment certification process shall cover the transmission of these data items.



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(c) Point 6 of Part A is deleted

(d) Point 1 of Part B replaced by the following

1. The minimum capability for the secondary surveillance transponder shall be Mode S Level 2 meeting the performance and functionality objectives of Annex 10 to the Chicago Convention, Volume IV, Third Edition including all amendments up to No 77.

(e) Point 16 of Part B deleted

(f) Point 4 of Part C replaced by the following

4. The data items referred to in point 3 shall only be transmitted by the transponder via the Mode S protocol. The aircraft and equipment certification process shall cover the transmission of these data items.

12. ANNEX IV is replaced by the following.

Requirements for the establishment of formal arrangements referred to in Article 5(2)

Formal arrangements between air navigation service providers for the exchange or providers of surveillance data shall include the following minimum content:

(a) the parties to the arrangements;

(b) the period of validity of the arrangements;

(c) the scope of the surveillance data;

(d) the sources of the surveillance data;

(e) the exchange format of the surveillance data;

(f) the service delivery point of the surveillance data;

(g) agreed service levels in terms of the following;

— surveillance data performance as established by Art 4(3)

— procedures in case of unserviceability,

(h) change management procedures;

(i) reporting arrangements with respect to performance and availability including unforeseen outage;

(j) management and coordination arrangements;

(k) ground-based surveillance chain safeguarding and notification arrangements.

13. ANNEX VI is deleted.

Article 2



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Regulation (EU) No 1206/2011 is amended as follows.

1. Article 5, is deleted.
2. Article 8, is deleted:
3. Article 9, is replaced by the following:
 1. Operators shall ensure that the setting of the downlinked aircraft identification feature referred to in paragraph 4 complies with item 7 'aircraft identification' of the flight plan referred to in point 2 of the Annex to Commission Regulation (EC) No 1033/2006 ⁽⁵⁾.
 2. Operators of those aircraft having the capability to change the downlinked aircraft identification feature referred to Annex II to Regulation (EU) 1207/2011 when airborne shall ensure that the downlinked aircraft identification feature is not changed during the flight unless requested by the air navigation service provider.
4. Article 10, is deleted:
5. Article 11, is replaced by the following:
 1. For the specific case of approach areas where air traffic services are provided by military units or under military supervision and when procurement constraints prevent compliance with Article 4(2), Member States shall communicate to the Commission by 1 January 2019, the date of compliance with downlinked aircraft identification , which shall not be later than 2 January 2025.
 2. Following consultation with the Network Manager and EASA and not later than 31 December 2020, the Commission shall review the exemptions communicated under paragraph 1 that could have a significant impact on the EATMN. If the exemptions do not comply with the objectives of this Regulation the Commission shall inform the Member State of the finding. The Member State concerned shall revoke the exemption.
6. Added the following to point 3 of ANNEX II
 - (d) State aircraft engaged on nationally sensitive operations or training, that require security and confidentiality.
7. ANNEX IV is deleted:

Article 3

Regulation (EU) No 2017/373 is amended as follows.

1. ANNEX VIII Part-CNS is amended as follows:
 - (a) CNS.TR.100 point (e) is replaced with the following and the existing point (e) is renumbered as point (f).



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(e) Notwithstanding point (d) the cooperative surveillance system shall comply as a minimum with the requirements of Volume IV on surveillance radar and collision avoidance systems 4th edition July 2007, including all amendments up to and including No 85 and shall be compatible with airborne transponders meeting the performance and functionality objectives of Annex 10 to the Chicago Convention, Volume IV, 3rd edition including all amendments up to and including No 77.

Article 4

Entry into force

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels,

For the Commission
The President



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Annex II

Draft ICAO Difference

The following differences will exist upon the adoption of the amendments proposed between the regulations_ and the provisions of Annex 10 Volume IV of the 5th edition including all amendments up to and including No 89.

a) Annex Provision	b) Difference Category	c) Details of Difference	d) Remarks
ICAO Annex 10, Vol. IV – concerning the operations and working procedures related to surveillance based SSR Mode S and ADS-B	C	For the carriage and operation of airborne and ground surveillance systems using Mode S and ADS-B systems complies as a minimum with the Annex 10 Volume IV of the 3 rd edition including all amendments up to and including No 77 and Annex 10 Volume IV of the 4 th edition including all amendments up to and including No 85 respectfully	<p>COMMISSION IMPLEMENTING REGULATION (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky</p> <p>And</p> <p>COMMISSION IMPLEMENTING REGULATION (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011</p> <p>As amended by</p> <p>COMMISSION IMPLEMENTING REGULATION (EU) .../.. of XXX amending Commission Implementing Regulation (EU) No 1207/2011, 1206/2011 and 2017/373</p>



