International Civil Aviation Organization

MIDANPIRG Communication, Navigation and Surveillance Sub-Group (CNS SG/15)

(Doha, Qatar, 11 – 14 May 2026)

Agenda Item 4: Surveillance Issues

REVIEW THE MID REGION SURVEILLANCE PLAN

(Presented by the Secretariat)

SUMMARY

This paper presents the MID Region Surveillance Plan, edition May 2023 (ICAO MID Doc 013) for review and update as appropriate.

Action by the meeting is at paragraph 3.

REFERENCES

- MIDANPIRG/20 Report
- ICAO MID Doc 013 (MID Region Surveillance Plan)

1. INTRODUCTION

1.1 The Aeronautical surveillance systems are major elements of modern air navigation infrastructure required to safely manage increasing levels and complexity of air traffic.

1.2 The sixteenth meeting of Air Navigation Planning and Implementation Regional Group in the Middle East (MIDANPIRG/16) tasked the CNS SG through Decision 16/24 to develop the MID Region Surveillance Plan based on the Regional operational requirements, Users' capabilities, and specificities of the Region.

1.3 The MID Region Surveillance Plan has undergone several revisions. The current version was endorsed by MIDANPIRG/20 through Conclusion 20/51 and is provided in ***Appendix A.***

2. DISCUSSION

2.1 The current version of the MID Region Surveillance Plan includes the outcome of ICAO Emerging Surveillance Symposium (5-7 September 2023, Tunisia, Tunis), and lessons learned regarding ADS-B implementation in the MID Region, as well as the outcome of ADS-B Webinar.

2.2 The meeting may wish to note that the current edition of the MID Region Surveillance Plan contains several items that are now obsolete and require review and update, including:

- The GANP Surveillance Plan, which no longer exists in the current version of the online GANP;
- The baseline of surveillance infrastructure in the MID Region, which is dated December 2020;
- The medium- and long-term actions need to be updated;
- The timeline for DFMC GNSS is inaccurate;
  The plan for ADS-B implementation in the MID Region is no longer relevant in light of prevailing GNSS RFI conditions; and
- The implementation of ADS-B/IN

3. ACTION BY THE MEETING

3.1 The meeting is invited to review the MID Region Surveillance Plan at ***Appendix A*** to this paper and discuss and agree on the approach and timeline for updating and endorsing the Plan, taking into account the CNS SG's workload and other regional priorities.

MID DOC 013

INTERNATIONAL CIVIL AVIATION ORGANIZATION

MIDDLE EAST AIR NAVIGATION PLANNING
AND IMPLEMENTATION REGIONAL GROUP
(MIDANPIRG)

MID REGION SURVEILLANCE PLAN

EDITION MAY 2023

Developed by:

MIDANPIRG COMMUNICATION, NAVIGATION AND SURVEILLANCE SUB-GROUP (CNS SG)

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1- BACKGROUND

Aeronautical surveillance systems are major elements of modern air navigation infrastructure required to safely manage increasing levels and complexity of air traffic. The sixteenth meeting of Air Navigation Planning and Implementation Regional Group in the Middle East (MIDANPIRG/16) tasked the CNS SG through Decision 16/24 to develop the MID Region Surveillance Plan based on the Regional operational requirements, Users' capabilities and specificities of the Region:

DECISION 16/ 23: MID REGION SURVEILLANCE PLAN

That, the MID Region Surveillance Plan be developed by the CNS SG, based on the operational needs identified by the ATM SG.

The Global Air Navigation Plan (GANP) through B0-ASUR, defined the possibility of using lower-cost ground surveillance supported by technologies such as ADS-B OUT and Wide Area Multilateration (MLAT) systems.

This document reviews the available surveillance technologies and highlight their strengths and weaknesses. The plan timelines are divided into three stages; short-term until 2020, mid-term from 2021 to 2025, and long-term beyond 2025.

2- INTRODUCTION

The surveillance service delivered to users may be based on a mix of three main types of surveillance:

a) independent non-cooperative surveillance: the aircraft position is derived from measurement not using the cooperation of the remote aircraft; like Primary Surveillance Radar (PSR);

b) independent cooperative surveillance: the position is derived from measurements performed by a local surveillance subsystem using aircraft transmissions. Aircraft derived information (e.g., pressure altitude, aircraft identity) can be provided from those transmissions, like Secondary Surveillance Radar (SSR) and Multilateration; and

c) dependent cooperative surveillance: the position is derived on board the aircraft and is provided to the local surveillance subsystem along with possible additional data (e.g., aircraft identity, pressure altitude), like Automatic Dependent Surveillance-Broadcast (ADS-B) and Automatic Dependent Surveillance-Contract (ADS-C).

The main applications of ATC Surveillance in civil aviation are:

1- Aerodrome Control Service;
2- Approach Control Service;
3- Area Control Service; and
4- Surface/ Ground Management

3- SURVEILLANCE IN GANP

The GANP addressed operating and emerging Surveillance technologies through the thread Alternative Surveillance (ASUR). The technologies laid down in that module are ADS-B, MLAT, and Mode S.

The lower costs of dependent surveillance infrastructure (ADS-B and MLAT) in comparison to conventional radars support business decisions to expand radar-equivalent service volumes and the use of radar-like separation procedures into remote or non-radar areas.

The eleventh Air Navigation Conference recommended ADS-B on 1090MHz for international use, and this is happening. Equipage rate is growing for Mode S, airborne collision avoidance system (ACAS), and ADS-B OUT. ADS-B OUT, Version 2 also provides ACAS RA DOWNLINK information.

The GANP Surveillance roadmap is depicted in *figure (1).* Alternative Surveillance elements as mentioned in the GANP 7th edition, are listed in *figure (2)*

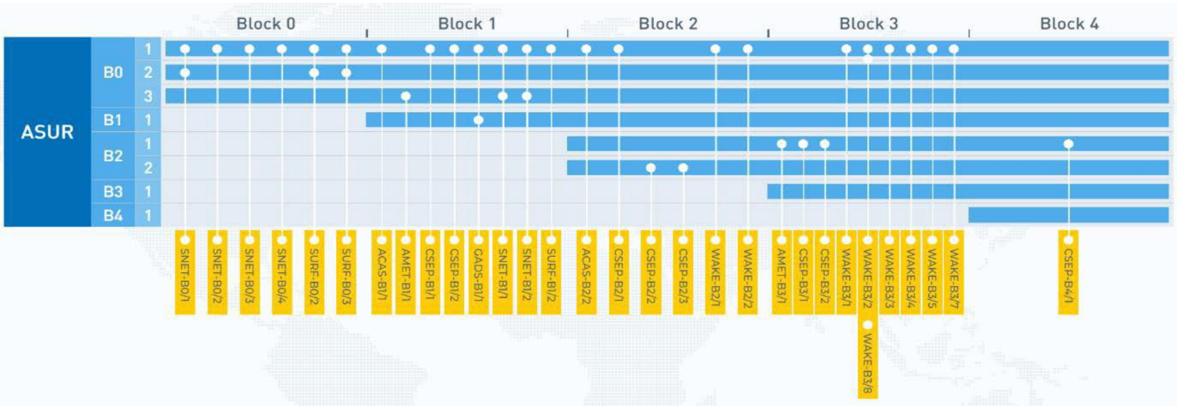


Figure (1)

Element ID	Title
ASUR-B0/1	Automatic Dependent Surveillance – Broadcast (ADS-B)
ASUR-B0/2	Multilateration cooperative surveillance systems (MLAT)
ASUR-B0/3	Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS)
ASUR-B1/1	Reception of aircraft ADS-B signals from space (SB ADS-B)
ASUR-B2/1	Evolution of ADS-B and Mode S
ASUR-B2/2	New community based surveillance system for airborne aircraft (low and higher airspace)
ASUR-B3/1	New non-cooperative surveillance system for airborne aircraft (medium altitudes)
ASUR-B4/1	Further evolution of ADS-B and MLAT

Figure (2)

- RFI

The potential increase of safety risks due to 1090 MHz congestion; it was highlighted that States should monitor and report the performance and the use of this RF band; detect and investigate the unexpected transmissions on these frequencies; and Study the interoperability impact between existing and new systems on this RF band.

4- SURVEILLANCE TECHNOLOGIES

4-1 Primary Radar

Primary Surveillance Radar (PSR) derives aircraft position based on radar echo returns, PSR transmits a high-power signal, some of which is reflected by the aircraft back to the radar. The radar determines the aircraft's position in range from the elapsed time between transmission and reception of the reflection.

Surface Movement Radar (SMR) is the most widely used non-cooperative surveillance system for aerodrome surveillance. SMR may use a primary radar for providing surveillance cover for the manoeuvring area, which is defined as that used for the take-off, landing and taxiing of aircraft. In A-SMGCS, the non-cooperative surveillance service is typically provided by one or several SMRs.

Millimetre radar is an emerging technology used for aerodrome surveillance which provides higher resolution than traditional SMR. Millimetre Radar and SMR can be used for FOD Detection.

The strengths and weaknesses below are related to the PSR.

4-1-1 Strengths

- independent Radar, does not require any specific equipment of the aircraft (Transponder).

4-1-2 Weaknesses

- does not provide the identity or the altitude of the Aircraft
- cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions
- PSR has a heavy reliance on mechanical components with large maintenance requirements
- high CAPEX
- can report false target
- depends on the cross section of the target
- Silence Cone
- Requires high transmission power.

4-2 Secondary Surveillance Radar (SSR/MSSR)

A surveillance radar system which uses transmitters/receivers (interrogators) and Aircraft transponders.

4-2-1 Strengths

- receive aircraft data for barometric altitude and identification code
- depends on Reply pulses, which are stronger than echo signals used in Primary Radar.
- Separate frequency spectrum for transmission and reception, Clutter reduction

4-2-2 Weaknesses

- high CAPEX
- cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions
- has a heavy reliance on mechanical components with large maintenance requirements
- Silence Cone

4-3 Mode S Radar

An enhanced mode of SSR that permits selective interrogation and reply capability.

4-3-1 Strengths

- improve shortage and constraints in Mode A codes (Aircraft ID)
- backward compatible with transponder mode A/C
- ability to download enhance surveillance information
- increase in data integrity by the use of a parity check mechanism.
- high parametric altitude accuracy (Coding of altitude data in 25-foot increments).

4-3-2 Weaknesses

- has a heavy reliance on mechanical components with large maintenance requirements
- cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions
- high CAPEX
- Silence Cone

4-4 ADS-B

Dependent surveillance is a surveillance technology that allows avionics to broadcast an aircraft's identification, position, altitude, velocity, and other information.

4-4-1 Strengths

- improve shortage and constraints in Mode A codes (Aircraft ID)
- Low ground infrastructure cost
- Easy to maintain
- The non-mechanical nature of the ADS-B ground infrastructure make it easy to relocate and maintain.
- it to be sited in locations that are difficult for radar installations, like hilly areas, filling the surveillance gap between radar coverage
- provide radar-like separation procedures into remote or non-radar areas
- Use of dependent surveillance also improves the search and rescue support provided by the surveillance network, ADS-B's positional accuracy and update rate allows for improved flown trajectory tracking allowing for early determination of loss of contact and enhances the ability for search and rescue teams to pinpoint the related location
- no Silence Cone

4-4-2 Weaknesses

- aircraft must be equipped with ADS-B OUT
- dependent on GNSS, outage of GNSS affect ADS-B

4-5 ADS-C

The aircraft uses on-board navigation systems to determine its position, velocity and other data. A ground ATM system establishes a "contract" with the aircraft to report this information at regular intervals or when defined events occur. This information is transmitted on point-to-point data links.

4-5-1 Strengths

- can be easily sited in oceanic locations, or rough terrain such as in mountainous regions
- does not need ground infrastructure when supported via satellite systems
- low investment cost at ANSP
- use of dependent surveillance also improves the search and rescue support provided by the surveillance network

4-5-2 Weaknesses

- high cost per report, as the airline use third party network.
- long latency when satellite used.

The ADS-C used in Oceanic and remote areas (non-Radar area), therefore, it will be excluded in the next section as it's not applicable in the MID Region.

4-6 MLAT

MLAT is a system that uses existing aircraft transponder signals to calculate, usually as a minimum, a three-dimensional position. it requires a minimum of four receiving stations to calculate an aircraft's position. If the aircraft's pressure altitude is known, then the position may be resolved using three receiving stations.

MLAT can act in two modes; Passive mode where it uses the existing transmissions made by the aircraft, or active mode, one interrogator (at least) to trigger replies in the manner of Mode S SSR interrogations.

The technique can be used to provide surveillance over wide area (wide area MLAT system - WAM).

4-6-1 Strengths

- can make use of currently existing aircraft transmissions, does not requires specific avionic.
- improve shortage and constraints in Mode A codes (Aircraft ID)
- provides a transition to an environment where the majority of aircraft will be equipped with ADS-B.
- no Silence Cone.

4-6-2 Weaknesses

- requires multiple receiving sensors to calculate aircraft's positions
- high running cost; including maintenance; telecommunication; multiple secured sites
- needs a common time reference to determine the relative TOA of the signal at the receiving stations (time-stamped by a common clock or synchronism by a common reference such as GNSS)

4-7 Surveillance Cameras

Surveillance Camera can be used to send high-resolution images at the airport to a workstation in the control tower. Surveillance Camera is an enabler to run remotely aerodrome control as in ASBU module B1-RATS. The air traffic controller can monitor air traffic via screens which provide an image that corresponds to the view through the window in a traditional control tower.

4-8 Precision Approach Radar (PAR)

Primary radar equipment used to determine the position of an aircraft during final approach, in terms of lateral and vertical deviations relative to a nominal approach path, and in range relative to touchdown. PAR is still used by military organizations. with ILS being part of the standard aircraft equipment (together with VHF radio and VOR), airline users no longer derive benefit from this technology

5- COMPARISON BETWEEN SURVEILLANCE TECHNOLOGIES

	PSR	MSSR	Mode S	ADS-B	MLAT
1)Required Avionics	No avionics required	Transponder is required Mode A/C	Transponder is required Mode S transponder	Transponder is required ADS-B or 1090 ES (Mode S + ADS-B)	Transponder is required Can process data from all ADS-B/ES, Mode S, Mode A/C
2)Information Provided	Range and Azimuth	Mode A codes, Pressure altitude	Mode A codes; Pressure altitude; 24-bit address of the aircraft; aircraft “on-the-ground” status; aircraft ID; aircraft pressure-altitude with 25-ft resolution; and other information	Position, flight level (barometric), position integrity, geometric altitude (GPS altitude), 24 bit unique code, Flight ID, velocity vector, vertical rate, emergency flags, aircraft type category	Position, flight level (barometric), calculated altitude, 4 digit octal identity, calculated velocity vector +mode s data
3)Accuracy & update rate	Accuracy depends on target cross-section and range	Dependent on range	Dependent on range	High accuracy ,inherent accuracy of the GPS determined position, and very high update rate	High accuracy at Local Area (LAM), less accurate for Wide Area (WAM) Some MLAT has its own of source

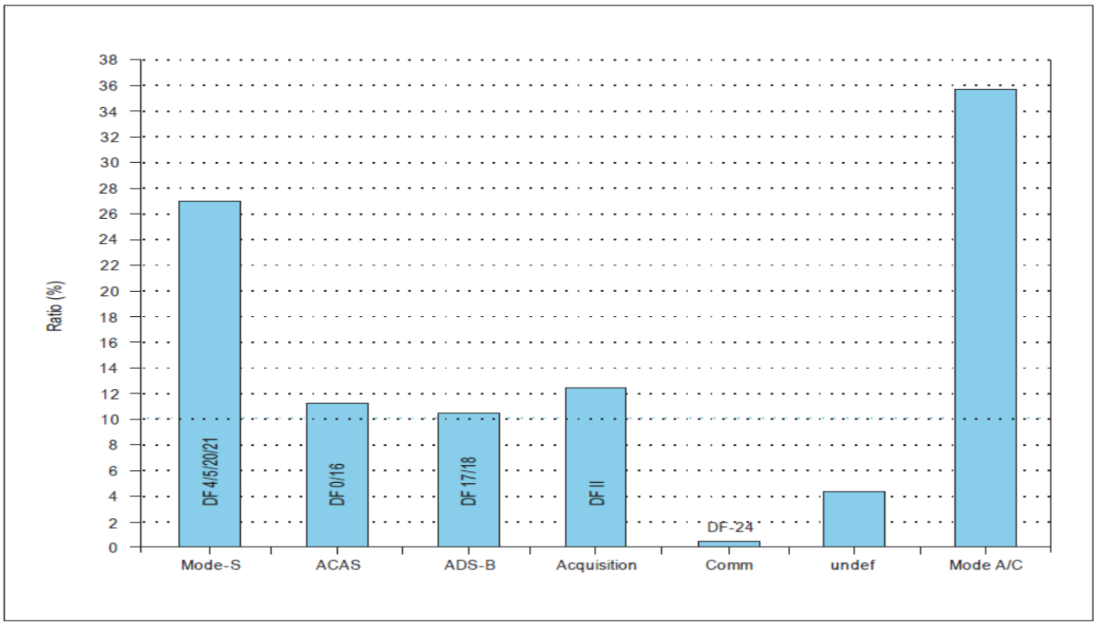
					of synchronization GNSS is critical for some MLAT for time synchronization.
4)Coverage	Up to 250 NM	250 NM	250 NM	250 NM Traffic density can affect the coverage	**Depending on the geometry,number of sensors, hilly areas requires more sensors
5)Failure effect		Total loss of coverage	Total loss of coverage	Total loss of coverage	Partial or negligible, (N-1) principle
	6) Cost*				
	6.1 CAPEX				
Sensor Purchase	Very high	High	high	very low	Depending on geometry,
Site requirement (Civil work, renting/buying land(s), fence,…, etc.)	One site required High cost of the tower	One site required High cost of the tower	One site required High cost of the tower	One site required Cost less	Multiple sites required
	6.2 OPEX				
Maintenance cost (periodic, preventive, emergency)	Heavy maintenance (mechanical parts)	Heavy maintenance (mechanical parts)	Heavy maintenance (mechanical parts)	Low maintenance cost	High maintenance costs to multiple sites
Telecommunication media	Dual Telecom. connections Required from the sensor site. to the ATM centre	Dual Telecom. connections Required from the sensor site to the ATM centre	Dual Telecom. connections Required from the sensor site to the ATM centre	Dual Telecom. connections Required from the sensor site to the ATM centre	Multiple Dual Telecom. connections Required From the sensors sites to the ATM centre
Site physical Security	One secured site	One secured site	One secured site	One secured site	Multiple secured Sites

**The cost does not take into consideration fleet equipage cost*

- **1090 SPECTRUM CONGESTION**

1090 CONGESTION SOURCES:

- SSR/MLAT replies
- TCAS/ACAS replies
- Squitters
  - – Acquisition Squitter (Mode S)
  - – Extended Squitter (ADS-B OUT)



SOURCE CONTRIBUTION EXAMPLE (ICAO DOC 9924)

1090ES (ADS-B) utilization of 1090 MHz grows linearly with equipped aircraft in a given airspace volume but is typically not the biggest user. TCAS/ACAS utilization of 1090 MHz grows by more than the square of equipped aircraft in a given airspace volume, use of Extended Hybrid Surveillance, which is required in ACAS Xa may be the mitigation measure

The 1090 MHz activity results from both SSR Mode A/C and Mode S type interrogators, however SSR Mode A/C operation is less spectrum efficient than Mode S SSR. Therefore, Managing interrogations in heavily surveilled airspace is very important o SSRs sharing surveillance data via networking (aka, "clustering"), thereby eliminating redundant surveillance coverage in overlapping geographic regions o Use of Passive Acquisition by SSRs and Wide-Area Multilateration

Mode S Downlink of Aircraft Parameters (DAPs) adds to 1090 MHz utilization, it should be used with caution. States with high dense FIR are encouraged to monitor 1090 MHz RF utilization.

States should ensure that aircraft transponders are not subject to excessive interrogations and that the use of a ground based transmitter do not produce harmful interference on other surveillance systems. States should monitor and report the performance and the use of this RF band; detect and investigate the unexpected transmissions on these frequencies; and study the interoperability impact between existing and new systems on this RF band.

States are urged to develop their contingency plans/procedures and back-up systems, to ensure continuous surveillance services/safe operations in the event of RFI or any malfunction of the Surveillance Systems. Furthermore, States are encouraged to take measures to mitigate RFI on surveillance systems:

- Use of multi constellation/multi frequency GNSS
- Employing multiple surveillance sensors in critical areas
- Use of monitoring and prediction tools/application

6. Operational Requirements

The need to increase the availability of Surveillance services and to cover the gap areas in the MID Region.

States to ensure that sufficient terrestrial CNS capabilities remain available to ensure safe operations and complement aircraft-level integration of position, velocity and time with independent surveillance information (Resolution A41-8, Appendix C)

7. Baseline in the MID Region (1/12/2020)

- All MID State uses SSR/MSSR, some States Uses PSR for Security and Safety purposes. Any user charges associated with existing PAR installations should be eliminated.
- Bahrain, Egypt, Oman and UAE implemented MLAT at International Aerodromes and Lebanon plan to do same.
- ADS-B has been implemented at some States as backup and complementary means to the MSSR in Egypt, Iraq, Jordan, Sudan and UAE.
- Bahrain has implemented ADS-B for Vehicle Tracking purpose.
- Bahrain, Egypt, Iraq, Jordan, Oman, Qatar, Saudi Arabia, Sudan and UAE have installed SSR Mode S.
- Saudi Arabia is using Combined PSR/MSSR and standalone MSSR Mode S in major TMAs to ensure adequate level of surveillance redundancy and identification of all flights;
- UAE issued ADS-B/Out carriage Mandate as of 01 January 2020, ADS-B IN capability shall not be carried unless approved by the GCAA.Saudi Arabia issued ADS-B/Out carriage Mandate as of 01 January 2023 for all airspace users flying in Class A, B, C, D and E.
- Other ICAO Regions/States mandated carriage of ADS-B; Australia, Europe and United States (FAA) in 2020.
- Several ADS-B mandates worldwide may accelerate the ADS-B equipage. However, Regional Airline, General flights and Military aircraft impeding the ADS-B implementation in the MID Region.
- Saudi Arabia is implementing A-SMGCS systems at all Intl. airports listed in ICAO MID ANP. Each A-SMGCS system is composed of: 1) an SMR system, 2) a network of MLAT and ADS-B ground Stations with required central processing and monitoring systems.

8- Surveillance Plan

8.1 Short Term (2020 – 2024)

- Make full use of SSR Mode 'S' capabilities, reduce reliance on 4-digit octal code.
- States to consider emerging dependent Surveillance technologies (ADS-B and MLAT) in their National Surveillance Plans.
- Non-cooperative Surveillance radars maybe retained for Airports and approach services based on States operational needs (detection drones with large Radar Cross Section (RCS), detection of non-equipped vehicle,…,etc).
- ADS-B/Out Implementation:

1- Prioritize ADS-B/Out implementation in areas where there is no radar coverage surveillance.
2- State shall conduct safety assessment for ADS-B/ MLAT implementation as per *Reference [6]*.
3- The proportions of equipped aircraft are critical for the ADS-B deployment. Therefore, States should involve early in their joint planning and decision-making process. Subsequently, States should effectively communicate the change, the rationale and the impact
4- States are encouraged to use INCENTIVE strategy with stakeholders to accelerate ADS-B equipage; incentive approach might be financial or operational incentive or combined (e.g. Most Capable Best Served principle, waive fees).

- MLAT/SMR/ADS-B to be implemented at Aerodrome to enable A-SMGCS.
- Where there is a lack of ADS-B avionics equipage, MLAT can be an alternative mean to meet specific surveillance requirements, such as being a gap-filler of SSR coverages or supporting airport ground movement operations.

- States to share SSR/ADS-B data to improve boundary coverage and enhance the surveillance availability services. These type of surveillance data have very limited military.

- Space based ADS-B can be used where installation of ground based surveillance sensor is not possible due to geography and other security reasons.

- Video Surveillance System can be used to operate Remote Control Tower (RATS B1/1).

- When operationally required, MLAT/SMR/Video Surveillance System may be implemented at Aerodrome for Ground/ Surface Management service.

8.2 *Mid Term (2025 - 2030)*

- ADS-B/Out Implementation (*High proportion of ADS-B equipage is anticipated):*
  1- ADS-B to be implemented for Area and approach Control Services, where implementation would bring capacity and operational efficiencies;
  2- Relocate, as appropriate, any existing MLAT Sensors to work as ADS-B receiver.

- Retain some SSR Mode S Radar as supplement/ backup to ADS-B. States should develop progressive rationalization plans base on consultations with aviation stakeholders.

- The Introduction of Multi-constellation GNSS (GPS, Galileo, GLONASS, …, etc.) may reduce the likelihood of ADS-B outage linked to GNSS interference events. However, necessary ICAO standards will need to be completed before any avionics deployment can be expected. Any use of multi-constellation capability should follow natural avionics life-cycle and should not be mandatory.

- Implementation of Airborne Collision Avoidance System (ACAS X) adapted to trajectory-based operations with improved surveillance function supported by ADS-B aimed at reducing nuisance alerts and deviations (ACAS B2/1)

- States to develop required certification requirements for RPAS equipped with ACAS X (detect and avoid system), the ACAS systems for RPAS use multiple surveillance sensor inputs to determine the position and velocity of nearby aircraft (ACAS B2/2)

- ICAO will be able to assign additional 24-bit addresses (adoption of Annex 10, VOL III amendment) to States who have a small number of addresses (such as 1024) and for allocating codes to surface vehicle.

8.3 *Long Term (2031 Onward)*

- ADS-B is foreseen to be main Surveillance technology. Globally harmonized avionics requirements and clear definition of roles, responsibilities, and liabilities of pilots and air traffic controllers should be developed in support of ADS-B IN applications. Subsequently, airlines and ATS providers should conduct a cost and benefit analysis for ADS-B IN to determine if a positive business case for airlines and ATS providers can be obtained.

REFERENCES

[1] ICAO Annex 10, Aeronautical Telecommunication.

[2] ICAO Doc 9924, Aeronautical Surveillance Manual

[3] ICAO Doc 9869, Performance-Based Communication and Surveillance (PBCS) Manual

[4] ICAO Doc 9994, Manual on Airborne Surveillance Applications

[5] The Global Air Navigation Plan (9750), 6th edition https://www4.icao.int/ganpportal/[6] ICAO Doc 9871, Technical Provisions for Mode S Services and Extended Squitter.

[6] ICAO circular 326, Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation

[7] EUROCONTROL Standard Document for RADAR Surveillance in EN-Route Airspace and Major Terminal Areas.

[8] Guidance Material on Comparison of Surveillance Technologies (GMST), APAC Region.

[9] ICAO Global Navigation Satellite System (GNSS) Manual (Doc 9849)

- END -