International Civil Aviation Organization

MIDANPIRG STEERING GROUP

Sixth Meeting (MSG/6)
(Cairo, Egypt, 3 – 5 December 2018)

Agenda Item 5.3: Specific Air Navigation issues

SURVEILLANCE MATTERS

(Presented by the Secretariat)

SUMMARY

This paper highlights the need for Training on Mode S IC Code Allocation (MICA) tool and presents the draft MID Region Surveillance Plan.

Action by the meeting is at paragraph 3.

1. INTRODUCTION

1.1 The Middle East Secondary Surveillance Radar (SSR) Code Management Plan (CMP) was endorsed by MIDANPIRG/13 through Conclusion 13/7, based on the outcome of the SSR Code Allocation Study Group (SSRCA SG).

1.2 MIDANPIRG/15 through Conclusion 15/32, endorsed the "MID Region Process for Mode S Interrogator Codes Allocation" as MID Doc 005, which is used for the allocation of the Mode S IC codes in the MID Region.

2. DISCUSSION

Surveillance/MICA Workshop

2.1 The meeting may wish to recall that MIDANPIRG/16 noted that MICA process is still not fully implemented/followed by some States, therefore, the meeting agreed to the following Conclusion:

CONCLUSION 16/22: MODE S INTERROGATOR CODE (IC) ALLOCATION

That, States, that have not yet done so, be urged to:

a) provide the ICAO MID Office with their Mode S Interrogator Code (IC) Focal Points; and

b) register to the MICA application for the allocation of the Mode.

2.2 During the past years of MICA operations, the need to conduct MICA Training for Operators from MID States was recognised. Therefore, the MID Office agreed with EUROCONTROL to organize a Surveillance/MICA Workshop in 2019.

MID Region Surveillance Plan

2.5 The meeting may wish to recall that MIDANPIRG/16, through Conclusion 16/23 agreed that a comprehensive MID Region Surveillance Plan should be developed by the CNS SG in coordination with the ATM SG, taking into consideration the Users' and States' operational needs and requirements.

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.

2.6 The CNS SG/8 meeting reviewed the MID Region Surveillance plan developed by the Secretariat and agreed that the plan needs further improvements. Accordingly, the meeting developed the following Draft Conclusion:

DRAFT CONCLUSION 8/9: MIDREGION SURVEILLANCE PLAN

*That, States review the Draft MID Region Surveillance Plan at Appendix 4G, and provide the ICAO MID Office with their comments/inputs by **15 April 2018** in order to present the consolidated version to the ATM SG/4 and ANSIG/3 meetings for further review and improvement.*

2.7 As a follow-up action, the ICAO MID Office circulated the draft MID Region Surveillance Plan. Replies received from four (4) States (Bahrain, Egypt, Jordan, and Qatar). States inputs have been incorporated into the plan as at **Appendix A.**

2.8 Furthermore, the ATM SG/4 reviewed the Draft MID Region Surveillance Plan, and the meeting agreed that ADS-B OUT would be used in the MID Region either to fill the gaps where radar coverage is not available or to be used as back up to the surveillance system in place.

2.9 Based on all the above, the meeting is invited to endorse the following Draft Conclusion:

DRAFT CONCLUSION 6/XX: MID REGION SURVEILLANCE PLAN AND WORKSHOP

That, with a view to provide MICA Operators with necessary knowledge to implement MICA processes efficiently, and in order to develop a comprehensive Surveillance Plan in the MID Region:

a) a Surveillance/MICA Workshop with support of EUROCONTROL be organised in February 2019;

b) States be invited to participate actively in the Workshop; and

c) the Draft MID Region Surveillance Plan be reviewed/updated during the Surveillance/MICA Workshop and presented to the MIDANPIRG/17 for endorsement.

3. ACTION BY THE MEETING

3.1 The meeting is invited to endorse, as appropriate, the Draft Conclusion at para. 2.9

MID Region Surveillance Plan

Version 0.2

24/4/2018

Developed by

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

TABLE OF CONTENTS

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 new 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; and

3- Area Control Service.
4- Surface/ Ground Management

3- SURVEILLANCE IN GANP

The GANP addressed the emerging Surveillance technologies through the thread Alternative Surveillance in block 0 (B0-ASUR), the technologies laid down in that module are ADS-B Out and MLAT.

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 together with Mode S, airborne collision avoidance system (ACAS) and ADS-B OUT mandates. ADS-B OUT, Version 2 also provides ACAS RA DOWNLINK information.

The GANP Surveillance roadmap is depicted in figure (1).

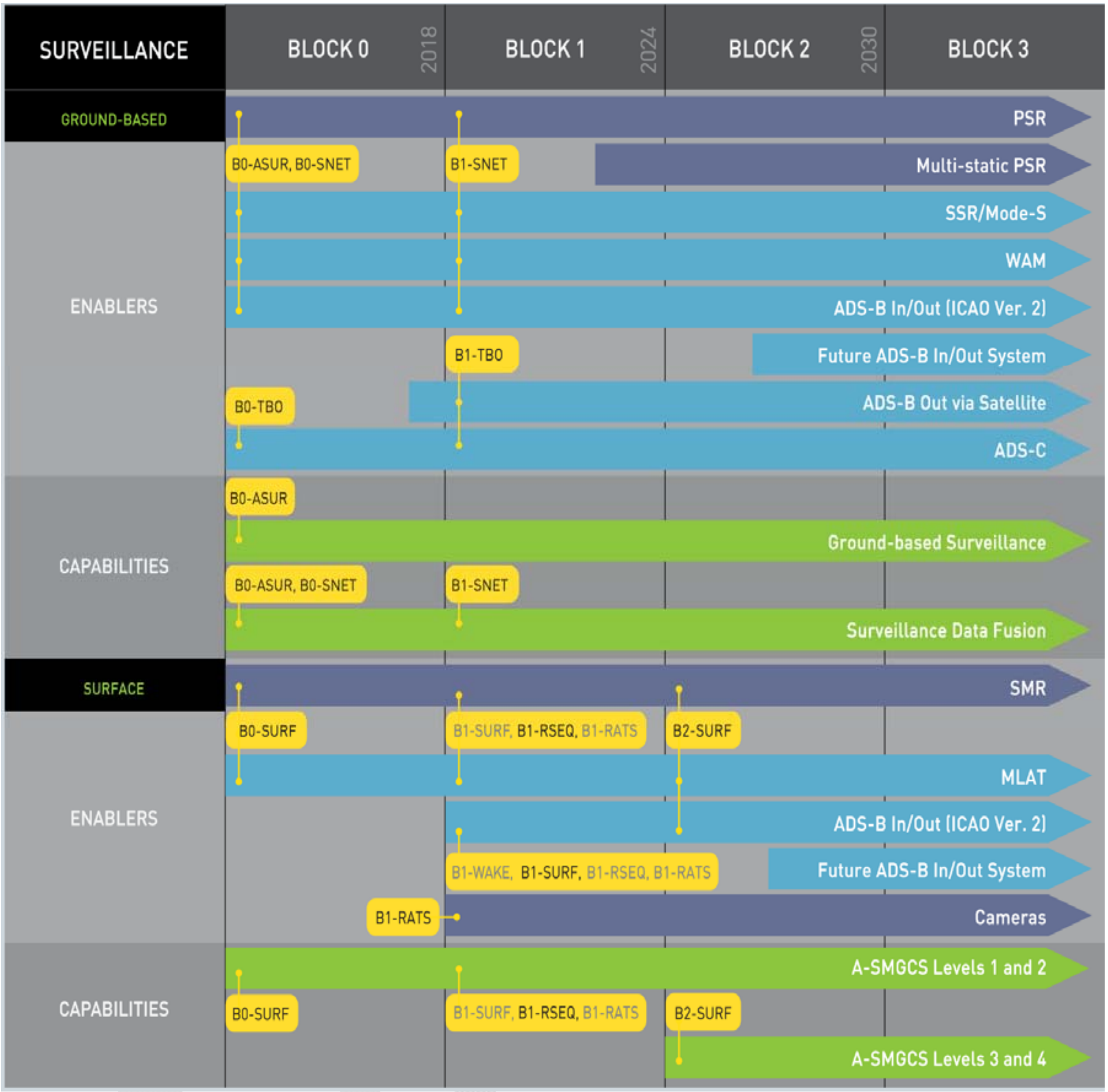

Figure (1)

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 is a primary radar that provides 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

4-2 Secondary Surveillance Radar (SSR/MSSR)

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

4-2-1 Strengths

- receive aircraft data for barometric altitude, 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 an advanced 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 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
- minimal 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 currently 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, to trigger replies in the manner of Mode S SSR interrogations.

The technique is 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 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.

5- Comparison between Surveillance Technologies

	MSSR	Mode S	ADS-B	MLAT
1)Required Avionics	Mode A/C	Mode S transponder	ADS-B or 1090 ES (Mode S + ADS-B)	Can process data from all ADS-B/ES, Mode S, Mode A/C
2)Information Provided	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	moderately high update rate high accuracy (Less than 30 m)	Moderately high update rate high accuracy (Less than 30 m)	High accuracy (Less than 30 m), inherent accuracy of the GPS determined position, and very high update rate	High accuracy at Local Area (LAM), less accurate for Wide Area (WAM) GNSS is critical for MLAT
4)Coverage	250 NM	250 NM	250 NM	**Depending on the geometry, covering 250NM may require 15 sensors as

				average, hilly areas requires more
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	3 M $	4 M$	300 K$	Depending on geometry, for 15 sensors average cost is 5M$
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 Cost less	15 sites required
6.2 OPEX				
Maintenance cost (periodic, preventive, emergency)	Heavy maintenance (mechanical parts)	Heavy maintenance (mechanical parts)	Less maintenance cost	High maintenance costs to multiple sites (15)
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	Multiple (15) Dual Telecom. connections Required From the sensor site to the ATM centre
Site physical Security	One secured site	One secured site	One secured site	Multiple (15) secured Site

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

*** Number of MLAT sensor depends on geometry area and number of clusters, 15 sensors is an estimated number to cover flat 250 NM.*

6. Operational Requirements

To be added by ATM SG

Airspace capacity requirements

Surveillance Gap areas exists in the Region

7. Baseline in the MID Region (24/4/2018)

- All MID State uses SSR/MSSR, some States Uses PSR for Security and Safety purposes.
- Bahrain, Egypt, Oman and UAE implemented MLAT at International Aerodromes
- ADS-B has been implemented at some States as backup and complementary means to the MSSR in Egypt, Jordan, Sudan and UAE.
- Bahrain has implemented ADS-B for Vehicle Tracking purpose.
- Bahrain, Egypt, Jordan, Oman, Sudan and UAE have installed SSR Mode S
- 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.
- Other ICAO Regions/States mandated carriage of ADS-B; Australia, Europe and United States (FAA) in 2020.
- Several ADS-B mandates worldwide will accelerate the ADS-B equipage. However, Regional Airline, General flights and Military aircraft impeding the ADS-B implementation in the MID Region.

8- Surveillance Plan

8.1 Short Term (2018 – 2020)

- 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.

- ADS-B/Out Implementation:
    1- Prioritize ADS-B/Out implementation in areas where there is no radar coverage surveillance.
    2- State should conduct safety assessment for ADS-B/ MLAT implementation as per *Reference [5].*
    3- The proportions of equipped aircraft are critical for the ADS-B deployment, therefore, States should early involve Users, 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 to be implemented at Aerodrome to enable A-SGMCS and approach

8.2 Mid Term (2021-2024)

- 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, WAM Sensors to work as ADS-B receivers.

- States to share Radar/ADS-B data to improve boundary coverage and enhance the surveillance availability.

- Retain SSR Mode S Radar as backup to ADS-B

- MLAT/SMR/Camera to be implemented at Aerodrome for Ground/ Surface Management service.

- Surveillance Camera can be used to operate Remote Control Tower (B1-RTAS).

8.3 Long Term (2025 Onward)

- ADS-B is foreseen to be main Surveillance technology. The existence of Multi-constellation GNSS (GPS, Galileo, GLONASS, …, etc.) reduces the likelihood of ADS-B outage.

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

- Airlines to upgrade ADS-B/Out Avionic to ADS-B in/out.

REFERENCES

[1] ICAO Annex 10, Aeronautical Telecommunication.

[2] ICAO Doc 9924, Aeronautical Surveillance Manual

[3] The Aviation System Block Upgrade Doc, July, 2016.

[4] ICAO Doc 9871, Technical Provisions for Mode S Services and Extended Squitter.

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

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

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

- END -