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

ENHANCING MODE S SURVEILLANCE PERFORMANCE THROUGH IMPROVED MANAGEMENT OF MICA AND MODE S INTERROGATOR CODES

(Presented by Saudi Arabia)

SUMMARY

This paper presents the importance of effective management of **M**ode **S** **I**nterrogator **C**odes (ICs) **A**llocation (MICA) and Surveillance Identifier (SI) codes in ensuring effective and optimal Mode S surveillance performance. Operational experience has shown that inadequate coordination and control of these codes and identifiers can result in aircraft misidentification, increased interrogation rates, degraded surveillance quality, and higher operational workload during the provision of ATC services. The paper outlines the importance of managing the MICA and SI codes to avoid the impact on surveillance integrity and operational safety, and proposes actions to harmonize Mode S code assignment, improve cross-border coordination, and enhance overall surveillance system performance within the MID region.

Action by the meeting is at paragraph 5 of this WP.

REFERENCES

- ICAO Annex 10 — Aeronautical Telecommunications, Volume IV
- MID eANP, Volume II – PART III — Communications, Navigation and Surveillance (CNS)
- ICAO Doc 9871 — Technical Provisions for Mode S Services and Extended Squitter
- ICAO Doc 9924 — Aeronautical Surveillance Manual.
- EUROCONTROL Mode S Interrogator Code Allocation Guidelines.
- ICAO MID Doc 013 - MID Region Surveillance Plan

1. INTRODUCTION

1.1 The Mode S secondary surveillance radar (SSR) systems are a fundamental component of modern air traffic management (ATM), supporting aircraft identification, altitude reporting, and data link applications.

1.2 The effectiveness of Mode S surveillance relies not only on system availability and coverage, but also on the correct configuration and management of Mode S parameters, in particular the Mode S Interrogator Code Allocation (MICA) and Surveillance Identifier (SI/II) codes.

1.3 Saudi Arabia has reported increasing instances of Mode S interrogation conflicts, code duplication, and aircraft misidentification on the western ATC sector. These issues are primarily attributed to inconsistent Mode S Interrogator Code Allocation (MICA) and Surveillance Identifier (SI/II) codes. The paper highlights the impact of the improper MICA and (SI/II) code management and propose harmonized measures to enhance Mode S surveillance performance and operational safety.

2. BACKGROUND

2.1 The Mode S Interrogator Code (ICs) Allocation is a unique surveillance address assigned by the EUROCONTROL Specification for the Mode S Allocation Coordination and IC Conflict Management (MICA). The correct programming of the MICA is essential to ensure accurate Mode S identification and the correlation of surveillance data across multiple radar ground stations and systems.

2.2 The Surveillance Identifier (SI/II) code is used to selectively address aircraft interrogations by individual sensors. Effective SI code management minimizes unnecessary interrogations, reduces RF congestion, and improves overall system efficiency.

2.3 Improper management of MICA and (SI/II) codes may result in:

1) Aircraft misidentification or duplication of targets on ATC displays;
2) Increased Mode S replies and interrogation rates leading to RF congestion;
3) Degradation of surveillance tracker, targets monitoring, and safety net performance;
4) Increased operational and technical workload; and
5) Potential safety risks for aircraft operations in complex or high-density airspace.

3. DISCUSSION

3.1 Surveillance Identifier (SI/II) codes are intended to support selective Mode S interrogations and to reduce unnecessary transponder replies. When SI codes are not systematically planned or coordinated across Mode S SSR ground stations, the intended benefits of selective addressing may not be fully achieved.

3.2 Uncoordinated SI/II code allocation causes neighboring radar/sensors to use identical identification codes in overlapping coverage areas. This creates conflicts where aircraft transponders are simultaneously interrogated by multiple systems, causing the sensors to lose track of locked aircraft and forcing an over-reliance on inefficient Mode S All-Call interrogations.

3.3 Excessive All-Call interrogations trigger unnecessary transponder replies, congesting the 1030/1090 MHz radio frequency. This overload degrades Mode S efficiency, corrupts data through signal interference, and ultimately compromises the accuracy and reliability of surveillance data delivered to Air Traffic Control (ATC) systems.

3.4 Uncoordinated Interrogator Codes (II/SI) among Mode S sensors cause severe radar interference, coverage gaps, and excessive RF pollution. Without centralized code assignment and overlapping coverage management, adjacent Secondary Surveillance Radars (SSRs) will struggle to selectively track aircraft, leading to overlapping "lockouts" and lost target data.

3.5 These inefficiencies in Secondary Surveillance Radar (SSR) Mode S networks occur when uncoordinated or poorly managed interrogator codes lead to overlapping sensor coverage. This causes aircraft transponders to experience interference, miss selective tracking signals, and generate excessive RF pollution.

1) Overlapping (SI/II) coverage between neighboring or co-located sensors that operate on the same Surveillance Identifier (SI) or Interrogator Identifier (II) codes. The Code conflicts arise, causing aircraft in overlapping zones to remain undetected by one or more radars.
2) Increased reliance on Mode S All Call interrogations to acquire aircraft. This clutters the 1030/1090 MHz frequency band with heavy Radio Frequency (RF) pollution and Garble/FRUIT (False Replies Unsynchronized in Time)
3) Reduced effectiveness of selective addressing and transponder lockout. Any Interference overrides these protocols, forcing aircraft to unnecessarily reply to every single interrogation, wasting transponder processing time and bandwidth.

3.6 Operation impact of unmanaged (SI/II) codes on ATC operation:

3.6.1 Unmanaged SI (Surveillance Identifier) code allocation disrupts air traffic control (ATC) by degrading radar track stability. The resulting signal interference can trigger a domino effect, leading to delayed target updates, garbled readouts, and dropped tracks that ultimately compromise flight safety in high-traffic environments. The excessive interrogations and replies overload the radar systems, ultimately culminating in at least the following consequences:

A- False targets

B- Loss of aircraft identification

C- Reduced surveillance accuracy

D- Increased ATC workload

E- Safety risks in high-density environments

3.6.2 Suboptimal Interrogator (II) and Surveillance Identifier (SI) code management in Mode S radars create severe operational risks. Poor code allocation causes overlapping radars to issue duplicate interrogations, leading to transponder lockouts, severe RF interference, and the loss of critical surveillance data. To effectively manage II/SI code utilization in increasingly dense airspace, air navigation service providers (ANSPs) must rely on strict, and coordinated strategies. The Proposed Technical enhancements can be summarized as follows:

A- Encourage the end user to conduct regular system audits or inspections to verify correct MICA, (SI/II) across the current surveillance system.

B- Reviewing ground surveillance infrastructure configurations to ensure optimized Surveillance Identifier (SI) code allocation prevents Mode S interrogator conflicts, eliminates synchronous garbling, and minimizes RF pollution.

C- Establish a Centralized MID Region IC Allocation Database: To prevent overlapping (SI/II) codes within standard radar coverage (e.g., 600 NM), a regional centralized registry similar to mechanisms established in the ICAO APAC and EUR regions is required to ensure cross-border de-confliction.

4. CONCLUSION

4.1 Effective management of MICA and (SI/II) codes is vital to maintaining Mode S system efficiency, reliability, and data integrity of Mode S ground surveillance systems.

4.2 To keep ground surveillance infrastructure safe and effective in modern Air Traffic Management (ATM), Mode S users must optimize how systems are configured, actively monitor system performance, and coordinate regionally. This collaborative approach ensures seamless, reliable radar and datalink operations as airspace grows more complex.

5. ACTION BY THE MEETING

5.1 The meeting is invited to:

a) Note the information presented in this working paper;

b) Acknowledge the impact of MICA and (SI/II) management on ground surveillance system performance;

c) Encourage MID States to review and enhance requirements on Mode S ground system configuration and monitoring practices; and

d) Agree to establish a MID Region Mode S Interrogator Code (IC) central regional repository, utilizing EUROCONTROL MICA principles, to proactively manage and de-conflict Mode S IC assignments across adjacent MID FIRs.

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