International Civil Aviation Organization

Ninth Meeting of the Surveillance Implementation Coordination Group (SURICG/9)

Bangkok, Thailand, 7 – 10 May 2024

Agenda Item 8: Review MODE S DAPs Implementation and Operations Guidance Document

RESERVATION OF IDENTIFIER CODES FOR TEST RADARS AND MILITARY RADARS

(Presented by Australia, Singapore and the Secretariat)

SUMMARY

This paper proposes a way forward on the reservation of II codes and matching SI codes for test and military radars.

1. INTRODUCTION

1.1 Arising from a study conducted by the Mode S and DAPs working Group, it is established that II codes are no longer sufficient to support the growing number of Mode S radars. ICAO APAC therefore made the decision to transit from the use of II codes to SI codes for the Mode S radars.

1.2 To aid the coordination and assignment of SI codes, a general strategy was proposed at MODE S AND DAPs WG/6 in March 2023 and adopted at APANPIRG/34 in December 2023 as attached in Annex A.

1.3 Some of the details pertaining to the reservation of II codes 14 and 15 (and their matching SI codes) for research/test radars and military radars still require further study and deliberation. This paper therefore proposes a way forward.

2. DISCUSSION

Recap

2.1 EUROCONTROL's practices

2.1.1 II code 0 and "matching" SI codes are reserved for mobile interrogators and systems that are not assigned a discrete code (e.g. MLAT and WAM). II code 14 (and its matching SI codes) are allocated to research/test Mode S radars in the ICAO EUR region. II code 15 (and its matching SI codes) are reserved for military operations in the ICAO EUR region, and they are managed by NATO. The other codes II codes 1 to 13 (and their matching SI codes) will be assigned to operational Mode S radars.

2.2 Existing situation in Asia Pacific

2.2.1 In the APAC region, II codes are assigned by the ICAO APAC office. Other than II code 0, all the other II codes (i.e., 1 to 15) were assigned to various Mode S Radars at various locations. In the recent years, the ICAO APAC office started to assign SI codes.

2.3 Proposal for using II codes 14 and 15 during Mode S DAPs WG/4 in March 2021

2.3.1 It was proposed by Australia that the APAC region adopt a similar approach as EUROCONTROL. The recommendation is for II code 14 (and its matching SI codes) to be reserved for Mode S radars used for research/test. For II code 15 (and its matching SI codes), it is recommended to be reserved for military use, and the management of the codes be delegated to State military agencies.

2.3.2 In the following year, a study showed that II codes 14 and 15 (and their matching SI codes) were already assigned to existing civil radars and that there were insufficient II codes to be re-assigned to these radars. The feasibility of Australia's proposal would also take some time to be studied. The proposal was therefore put on hold until such time when the APAC region could free up some IC codes from the migrating of II to SI codes.

2.4 General Strategy on Migration to SI code proposed in Mode S and DAPs WG/6 in March 2023 and adopted by APANPIRG/34 in December 2023

2.4.1 In the General Strategy on Migration to SI proposed by China and Singapore, it was mentioned, *inter alia*, that ICAO APAC office will generally avoid assigning II codes 14 and 15 (and their matching SI codes) to new Mode S radars. However, the feasibility of reserving II codes 14 (and its matching SI codes) for Mode S radars used for research/test and delegating the allocation of II codes 15 (and its matching SI codes) for military radars are yet to be studied.

Considerations in APAC Region

2.5 Amount of testing and research radars

2.5.1 Within the EUR region, there are many States with radar manufacturers and research facilities that have Mode S radars under test and research. There are about 50 test radars assigned to II codes 14 (and its matching SI codes) in EUR region. Whereas within the APAC region, there were only few States having similar facilities. Reserving II codes 14 (and its matching SI codes) could be wasting precious codes.

2.6 Ability for State military agencies to coordinate and assign IC

2.6.1 Within the EUR region, NATO can act as a coordination body for the allocation of IC codes for the military radars of European States. For the case of APAC region, there is no similar coordination body among the military of APAC States.

2.7 Other considerations

2.7.1 One possible arrangement is to reserve II codes 15 (and its matching SI codes) for military radars and allow the military agencies to use these codes without coordination.

2.7.2 It is also noted that in APAC region, there are some large States whereby its more efficient for the State and its State military agency to manage the assignment of IC of military radars.

Possible methods

2.8 Method 1: All ICs to be assigned by the ICAO APAC regional office (default)

2.8.1 This method requires all ICs for Mode S radars to be assigned by the ICAO APAC regional office. Under this method, II codes 14 and 15 (and their matching codes) will not be reserved for research/test radars and military radars. This allows maximum oversight for the use of ICs. But if there are frequent changes in radar locations, it will create additional workload for both the State and ICAO

APAC regional office.

2.9 Method 2: Following the practice in Europe

2.9.1 This method would reserve II codes 14 and 15 (and their matching SI codes) for research/test radars and military radars. II code 14 (and its matching SI codes) will be assigned by ICAO APAC regional office for research/test radars while II code 15 (and its matching SI codes) will be assigned by State military agencies for military radars.

2.9.2 As there are limited test radars in the APAC region, reservation of II code 14 (and its matching SI codes) will be wasting resources.

2.9.3 Due to the lack of a central military coordination body in the APAC region, there will not be proper coordination of military radars using II code 15 (and its matching SI codes) except for large States which can coordinate within the boundary of the State.

2.10 Method 3: Reservation of II codes 14 and 15 (and their matching SI codes) for research/test and military radars within some States

2.10.1 This method allows some flexibility for ICAO APAC regional office to delegate the assignment of ICs [ie. II codes 14 and 15 (and their matching SI codes)] for research/test radars and/or military Mode S radars to some large States. These States can then choose to delegate the assignment process of the military Mode S radars to its military agencies. It is expected that some understanding must be agreed upon between the State and the ICAO APAC office (e.g. freedom of assignments only up to a certain geographical boundary, typically where it's unlikely to have overlapping coverage with radars from another State). Other than what was delegated to the States, assignment of ICs for radars (including research/test radars and military radars) will be by the ICAO APAC regional office as per method 1.

Recommendation

2.11 Getting the ICAO APAC regional Office to manage all the allocation as mentioned in method 1 is not the most efficient. Following the practice from EUROCONTROL to reserve II codes 14 and 15 (and their matching SI codes) on a region-wide basis as mentioned in method 2 is not suitable for the APAC region. Probably a mixture of both as mentioned in method 3 can strike a balance.

2.12 If the meeting is agreeable with method 3, the General Strategy adopted by APANPIRG/34 will be updated accordingly with the Decision below:

<table>
<tr><td colspan="3">Conclusion/Decision XX/XX - UPDATE OF THE GENERAL STRATEGY ON ASSIGNMENT OF AND MIGRATION TO SI CODE IN THE APAC REGION</td></tr>
<tr><td colspan="2">What: Study by SURICG concluded that reservation of II codes 14 and 15 (and their matching SI codes for research/test radars and military radars on a region-wide basis is not feasible. Instead, certain States (e.g. large States) could request the ICAO APAC office the delegation of authority to assign II codes 14 and 15 (and their matching SI codes) for research/test radars and military radars within a certain geographical boundary (typically, where it's unlikely to have overlapping coverage with radars from another State).</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☐ Ops/Technical</td></tr>
<tr><td colspan="2"></td><td>Follow-up: ☐Required from States</td></tr>
<tr><td colspan="2">When: 10-May-24</td><td>Status: Draft to be adopted by PIRG</td></tr>
<tr><td colspan="3">Who: ☐Sub groups ☐APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other: XXXX</td></tr>
</table>

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note the information presented in this paper;

b) Agree to the new Conclusion/Decision in paragraph 5 and the modifications to the General Strategy on the assignment of and migration to Mode S SI codes;

c) Discuss any relevant matters as appropriate.

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Annex A

GENERAL STRATEGY ON ASSIGNMENT OF AND MIGRATION TO SI CODE

Consider that when formulating the general strategy:

a) It was previously shared that radars using SI code cannot detect II-only transponders unless a work-around known as the II/SI code operation is used;

b) Even if a radar using SI code supports the II/SI code operation, it will not be able to detect an II-only transponder if that transponder is already locked to a matching II code by a radar using that matching II code. A way to overcome this is for II radars to also use the II/SI code operations whereby it will only lock out SI-capable transponders and not II-only transponders. However, it is difficult to ensure that all radars (including old radars) can support the II/SI code operations;

c) Transponders that support only II codes are unlikely to disappear totally. Even with strict enforcement by ICAO, there will still be aircraft not subjected to ICAO's provision;

d) While it is possible to configure the lock-out coverage to be smaller than the designated operating coverage, such configuration may not be intuitive and may be subjected to error;

e) The European region is reserving II 14 and 15 (and their matching SI codes) for special use (i.e. research/test and military purposes);

f) The Surveillance Panel is deliberating on a proposal to include a **requirement** for use of II/SI code operations for radars using SI code and a **recommendation** for the use of II/SI code operations for radars using II code; and

g) The strategy is to be kept simple,

The following general strategy is thus proposed for the assignment of SI codes:

a) ICAO APAC regional office will assign SSR Mode S II or Mode S SI codes in accordance with the planning criteria in *Appendix A-1*, at the same time ensuring support for Mode S II-only transponders;

b) ICAO APAC regional office will only assign an SI code if the radar can support II/SI code operations;

c) ICAO APAC regional office will only assign an SI code to radars having overlapping coverage with another radar using "matching" II code when the radar using "matching" II code can support II/SI code operations;

d) The ICAO APAC Regional Office will assume that the designated operating coverage is the same as the lockout coverage. There will be a 5NM buffer between the coverages of two radars using the same II or SI code. States can, as necessary, select a lockout coverage that is smaller than the Designated Operational Coverage; and

e) The ICAO APAC regional office will generally avoid assigning II 14 and 15 (and their matching SI codes) to new radars.

The following general strategy for migration is proposed:

a) States with Mode S radars that can support II/SI code operation are encouraged to coordinate with the ICAO APAC Office to assign or re-assign SI codes to these radars.

b) The ICAO APAC Regional Office may also approach certain States to start migrating to SI codes.

Appendix A-1

The following planning criteria for assigning SSR Mode S II or SSR Mode S SI codes have been agreed by the Surveillance Panel and will be incorporated in the ICAO Aeronautical Surveillance Manual (DOC 9924)

(Editorial Note: Some of the texts below are edited from the original material in DOC. 9924)

Table 1: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II-only interrogator.
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code, including a "matching" SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Non-matching SI code	Overlap OK	II-only and II/SI
		Matching SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 2: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II/SI interrogator that does not support the use of II/SI code operation.
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code, including a "matching" SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Non-matching SI code	Overlap OK	II-only and II/SI
		Matching SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 3: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II/SI interrogator that does not support the use of II/SI code operation.
Operating on SI code
Can only operate with Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Any II code including the matching II code	Overlap OK	II/SI
B	Mode S SI operating with II code (1)	Any II code including the matching II code	Overlap OK	II/SI
C	Mode S SI operating with SI code (1)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	
D	Mode S II/SI+ operating with II code (2)	Any II code including the matching II Code	Overlap OK	II/SI
E	Mode S II/SI+ operating with SI code (2)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 4: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II/SI+ interrogator that supports the use of II/SI code operation.
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code including a matching SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Any SI code including a matching SI code	Overlap OK	II-only and II/SI

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 5: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II/SI+ interrogator that supports the use of II/SI code operation.
Operating on SI code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Non-matching II code	Overlap OK	II-only and II/SI
		Matching II code	No overlap	
B	Mode S SI operating with II code (1)	Non-matching II code	Overlap OK	II-only and II/SI
		Matching II code	No overlap	
C	Mode S SI operating with SI code (1)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	
D	Mode S II/SI+ operating with II code (2)	Any II code including a matching II code	Overlap OK	II-only and II/SI
E	Mode S II/SI+ operating with SI code (2)	Different SI code	Overlap OK	II-only and II/SI
		Same SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Annex B

GENERAL STRATEGY ON ASSIGNMENT OF AND MIGRATION TO SI CODE (revised)

Considering that, when formulating the general strategy:

a) It was previously shared that radars using SI code cannot detect II-only transponders unless a work-around known as the II/SI code operation is used;

b) Even if a radar using SI code supports the II/SI code operation, it will not be able to detect an II-only transponder if that transponder is already locked to a matching II code by a radar using that matching II code. A way to overcome this is for II radars to also use the II/SI code operations whereby it will only lock out SI-capable transponders and not II-only transponders. However, it is difficult to ensure that all radars (including old radars) can support the II/SI code operations in the near future;

c) Transponders that support only II codes are unlikely to disappear totally. Even with strict enforcement by ICAO, there will still be aircraft not subjected to ICAO's provision;

d) While it is possible to configure the lock-out coverage to be smaller than the designated operating coverage, such configuration may not be intuitive and may be subjected to error;

e) The European region is reserving II codes 14 and 15 (and their matching SI codes) for special use (i.e. research/test and military purposes). However, the situation in APAC region is different and only certain locations may benefit from the reservation of II 14 and 15 (and their matching SI code);

f) The Surveillance Panel is deliberating on a proposal to include a **requirement** for use of II/SI code operations for radars using SI code and a **recommendation** for the use of II/SI code operations for radars using II code; and

g) The strategy is to be kept simple,

The following general strategy has been agreed ~~is thus proposed~~ for the assignment of SI codes:

a) The ICAO APAC regional office will assign SSR Mode S II or Mode S SI codes in accordance with the planning criteria in *Appendix A-1,* at the same time ensuring continued support for Mode S II-only transponders;

b) The ICAO APAC regional office will only assign an SI code if the radar can support II/SI code operations;

c) The ICAO APAC regional office will only assign an SI code to radars having overlapping coverage with another radar using "matching" II code when the radar using "matching" II code can support II/SI code operations;

d) The ICAO APAC Regional Office will assume that the designated operating coverage is the same as the lockout coverage. There will be a 5NM buffer between the coverages of two radars using the same II or SI code. States can, as necessary, select a lockout coverage that is smaller than the Designated Operational Coverage; and

e) ~~The ICAO APAC regional office will generally avoid assigning II 14 and 15 (and their matching SI codes) to new radars.~~ The ICAO APAC regional office will not reserve II codes 14 and 15 (and their matching SI codes) on a region-wide basis. Instead, certain States (e.g. large States) could request from ICAO APAC regional office the delegation of authority to assign II codes 14 and 15 (and their matching SI codes) for research/test radars and military

radars within certain geographical boundary (typically, where it's unlikely to have overlapping coverage with radars from another State).

The following general strategy for migration has been agreed ~~is proposed~~:

a) States with Mode S radars that can support II/SI code operation are encouraged to coordinate this functionality with the ICAO APAC regional Office to assign or re-assign SI codes to these radars.

b) The ICAO APAC Regional Office may also approach certain States to start migrating to SI codes.