Supporting European Aviation

EUROCONTROL

Operation on II and SI codes

MICA Workshop for ICAO MID States
Agenda Item #3

Jérôme BODART

EUROCONTROL MICA Cell

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Interrogator Code

- An Interrogator Code (IC) is either:
  - Interrogator Identifier code (II code), or
  - Surveillance Identifier code (SI code)

- 16 II codes are available: II code 0 to II code 15
- 63 SI codes added in 1997: SI code 1 to SI code 63

Use of Interrogator Codes by Surveillance Systems

- Mode S radars
  - rely on All-Call interrogations and replies to acquire Mode S aircraft,
    - IC in All-Call interrogations and replies
  - lock out acquired Mode S aircraft
    - IC in selective interrogation
  - general purpose data-link protocols (selective interrogations)
  - ➔ Mode S radars require IC allocation (except when operating on II code 0)

- ADS-B are passive systems and don’t need an IC to operate
- Passive WAM systems don’t need an IC to operate

- Active WAM systems don’t use All-Call to acquire aircraft, don’t lock-out aircraft, but use selective interrogations to interrogate aircraft
  - IC is required, II code 0 is generally used
  - a discrete IC may be use by WAM systems if interrogations on 1030MHz need to be monitored

II Code 0 and matching SI Codes

- II code 0 is reserved by ICAO for Mode S interrogators that have not been assigned a unique discrete IC:
  - MLAT and WAM systems, and
  - Mobile Mode S interrogators for which it is not practical to allocate an IC
  - Operation on II 0 in accordance with the ICAO Standards and Recommended Practices
    - ICAO Annex 10 Vol IV Section §3.1.2.5.2.1.4. and §3.1.2.5.2.1.5.
    - Lockout override on II = 0 and Maximum All-Call interrogation rate

- II code 0 is not allocated by the MICA Cell
- SI codes matching II code 0 (SI 16, SI 32 and SI 48) are not allocated by the MICA Cell.

II Code 14 and matching SI Codes

- II code 14 and SI codes matching II code 14 (SI 14, SI 30, SI 46 and SI 62) are allocated to Test, Research and Development (TRD) Mode S radar in the ICAO EUR region and the ICAO MID region

II Code 15 and matching SI Codes

- II code 15 and SI codes matching II code 15 (SI 15, SI 31, SI 47 and SI 63) are reserved for military operations in the ICAO EUR region.
  - Non-fixed military radars
  - The management of these codes is under the responsibility of NATO.

- II code 15 and matching SI codes (SI 15, SI 31, SI 47 and SI 63) are not available for allocation by the EUROCONTROL MICA Cell in the ICAO EUR region

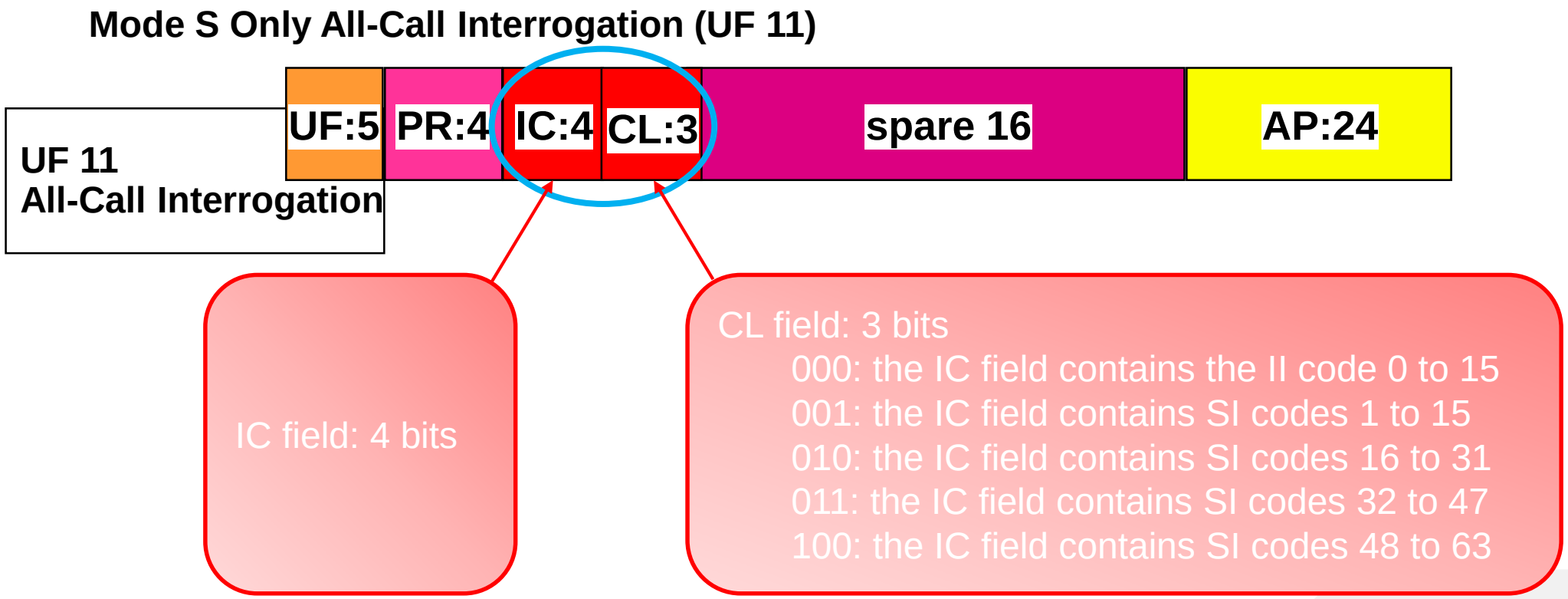
- According to MID Region IC allocation process - June 2015 (approved by MIDANPIRG/15 – 12/06/2015)
  - ICAO MID regional office to decide how to use II code 15 and SI codes matching II code 15

IC allocated by the MICA Cell for operation

- List of IC available for allocation to operational Mode S interrogators by the MICA Cell:
  - II code 01 and matching SI codes (SI 01, SI 17, SI 33, SI 49)
  - II code 02 and matching SI codes (SI 02, SI 18, SI 34, SI 50)
  - II code 03 and matching SI codes (SI 03, SI 19, SI 35, SI 51)
  - II code 04 and matching SI codes (SI 04, SI 20, SI 36, SI 52)
  - II code 05 and matching SI codes (SI 05, SI 21, SI 37, SI 53)
  - II code 06 and matching SI codes (SI 06, SI 22, SI 38, SI 54)
  - II code 07 and matching SI codes (SI 07, SI 23, SI 39, SI 55)
  - II code 08 and matching SI codes (SI 08, SI 24, SI 40, SI 56)
  - II code 09 and matching SI codes (SI 09, SI 25, SI 41, SI 57)
  - II code 10 and matching SI codes (SI 10, SI 26, SI 42, SI 58)
  - II code 11 and matching SI codes (SI 11, SI 27, SI 43, SI 59)
  - II code 12 and matching SI codes (SI 12, SI 28, SI 44, SI 60)
  - II code 13 and matching SI codes (SI 13, SI 29, SI 45, SI 61)
- (Note: II codes and matching SI codes have the same IC field value – see below)

II Code / SI Code encoding in All-Call Interrogations

- Mode S interrogations:
  - II code encoded in **IC field** (4 bits – 0 to 15)
  - SI codes encoded in **IC field** (4 bits) **+ CL field** (3 bits)



SI capable and II capable transponder

- SI code capable Mode S transponders recognize IC field and CL field (II and SI code)
  - SI code capability shall be provided […] by all Mode S transponder by 1 January 2005 (ICAO Annex 10 Vol. IV §2.1.5.1.7.1)

Issues

- Not all Mode S transponders are SI code capable
- Not SI code capable (II code capable) Mode S transponders recognize only the IC field
  → Only the II code part of the IC contained in the All-Call interrogations is decoded

SI capable and II capable transponder (2)

- SI code capable Mode S aircrafts decode correctly the SI code contained in the All Call interrogation (UF11) and reply on that SI code (DF11).
- II code capable Mode S aircrafts decode only the matching II code (IC field) in the All Call interrogation (UF11) and reply on that II code (DF11).
- Example: a radar operates on SI code 33 (IC=0001 and CL=011 in All-Call interrogations)
  - SI code capable transponder will decode correctly the SI code 33 in All-Call interrogations and will reply on SI code 33
  - II code capable transponder will decode II code 01 (II code matching SI code 33) in All-Call interrogations and will reply on II code 01
- Mode S radars operating on SI code (no II/SI code operation) can acquire Mode S aircraft which are SI code capable, but cannot acquire aircraft which are II code capable.
  - All-Call replies on II code are discarded by radar operating on SI code (no II/SI code operation)

Operation on SI code with II/SI code operation

- It is strongly recommended for Mode S radars to support II/SI code operation
- Mode S radars operating on SI code with II/SI code operation accept All-Call replies on the SI code and on the matching II code
  - Acquisition of Mode S aircraft which are SI code capable and Mode S aircraft which are not SI code capable (II code capable)
- IC (II code or SI code) provided in the All Call replies is used to determine if a Mode S aircraft is SI code capable or not.
- Mode S transponders which are not SI code capable shall not be locked-out on the matching II code to enable the acquisition:
  - by other Mode S radars operating on SI code having the same matching II code
  - by other Mode S radars operating on the matching II code

Operation on II code with II/SI code operation

- Mode S radars operating on II code with II/SI code operation use the SI code capability reported in Bit 35 of BDS 1,0 to determine if a Mode S aircraft is SI code capable or not.

- Mode S transponders reporting they are not SI code capable or not reporting their capability shall not be locked-out on the II code to enable Mode S radars operating on a matching SI code (with II/SI code operation) to acquire them on the II code if they are not SI code capable.

II/SI Code Operation in the European Union

- To support the use of SI code in European Union, requirements on SI code and II/SI code operation have been lay down in Article 3 of COMMISSION REGULATION (EC) No 262/2009 of 30 March 2009
  - All Mode S radar shall support the use of SI code
  - All Mode S radar shall support the use of II/SI code operation

Allocation strategy

- In ICAO EUR region, II codes and matching SI codes are allocated to Mode S radars with overlapping coverage
  - Mode S radars operating on **II codes and SI codes** have to enable the **II/SI code operation**
    - To acquire on the matching II code the aircraft which are not SI code capable, but no lockout
  - Monitoring means are in place to identify Mode S transponders which are not SI capable

- In ICAO MID region, II codes and matching SI codes are not allocated to Mode S radars with overlapping coverage:
  - IC allocations on II codes are removed in order to allocate the 4 SI codes matching the II code
  - **Not required** to enable the **II/SI code operation** on Mode S radars operating on **II Code**.
  - Mode S radars operating on **SI codes** have to enable the **II/SI code operation**
    - To acquire on the matching II code the aircraft which are not SI code capable, but no lockout
    - No regulation to support II/SI code operation in ICAO MID region
  - A shortage of IC may happen in the future if both the II codes and the matching SI codes cannot be allocated in the same region.