

RTCA Special Committee 209

Working Group #1

Mode S Transponder MOPS Development/Maintenance

Meeting #3

**Engility Corporation, Washington DC
2 – 4 October 2007**

Proposed change to manage transponder transition

Prepared by Eric Potier, Eurocontrol

SUMMARY

Mode S protocol introduces new modes of operation where the data are no more periodically extracted by ground systems but extracted only when airborne equipment indicates that something has changed. This working paper presents different issues demonstrating that the current implementation is not robust to transponder switch-off/switch-on or to transponder 1 to transponder2 switching. Different options are envisaged and one solution is proposed for possible further development.

1.0 Introduction

Mode S protocol introduces new modes of operation where the data are no more periodically extracted by ground systems but extracted only when airborne equipment indicates that something has changed.

For example Mode S protocol foresees the announcement of Mode A code change through an Alert flag transmitted in the FS field of DF=4, 5, 20, 21 messages. Similarly Aircraft identification present in register 20₁₆ will not be extracted each scan by radar but will be broadcast by the transponder in case of change.

During Mode S deployment in Europe it has been noted that the Mode A code change was not always announced to the ground and therefore the ground track remained with the initial Mode A code. Similarly, when performing safety analysis, another mode of operation resulting in no extraction of the data has been identified.

This Working Paper describes in more detail these different issues, proposed different options to solve them, and presents the current preferred ICAO ASP TSG approach.

2.0 First issue: Impact of a short switch-off / switch-on

A number of cases where the Mode A code change was not detected and therefore not extracted by ground stations were reported and analysed (see ICAO SCRSP WP B10-16).

Following analysis it was demonstrated that one of the reasons is that the transponder could be switched-off by the pilot during a short period of time just after having changed the Mode A Code. It has been reproduced and demonstrated in laboratory on small Mode S transponders used by General Aviation.

In such cases, the transponder loses the alert while keeping the new Mode A code. Everything seems OK for the Pilot but the Mode A code change indication is not transmitted to the ground. The interruption could be short and not detected at all by Mode S ground station therefore the track is not dropped and the new Mode A code is not extracted.

When a transponder is switched-off or switched-on for a short period of time the following may happen:

1. Loss of Mode A code temporary alert
2. Loss of Register 10₁₆ change announcement
3. Loss of Register 17₁₆ change announcement
4. Loss of AICB announcement
5. Loss of broadcast announcement
6. Loss of RA report broadcast announcement
7. Loss of SPI announcement
8. Loss of data-flash contracts

3.0 2nd issue: impact of switching from transponder 1 to transponder 2

Similar problems are also encountered when pilots switch from transponder 1 to transponder 2. With the current requirement and implementations, the ground system will not detect the change, and will not re-extract Mode A code, Aircraft capability, Aircraft ID, and will continue to believe that data-flash is correctly running when in fact it is not. This is annoying as the change from transponder 1 to transponder 2 may be triggered by the wrong Mode A code/ Aircraft ID reported by the first transponder.

4.0 Possible options

Different options could be envisaged to resolve this issue. When the transponder is leaving the OFF position, or stand-by position, the following could be envisaged:

1. to avoid effect 1, 2, 3, transponder could be required to set a temporary alert in the FS, broadcast Register 10₁₆, toggle bit 36 to reinitiate an extraction of register 17₁₆, broadcast Register 20₁₆.
2. Use a specific value in FS (e.g., 7) to announce to the ground that the transponder started transmission in the last 18s. When detecting such value in FS, ground stations could re-extract all airborne information as performed at track initiation.
Disadvantages: The use of FS 7 would mean that either no SPI could be announced for the first 18s or SPI has priority on 'start of transmission' announcement. Note that the non transmission of SPI could be critical as some controllers are used to use SPI when aircraft is taking off.
3. Use a specific value in DR (e.g., 8) to announce to the ground that the transponder started transmission in the last 18s.
Disadvantages: broadcast/AICB could not be announced for the first 18s switching on the transmission capability.
4. Set a dedicated bit in Register 10₁₆ (e.g., bit 10) to indicate that transmission has started in the last 18s. It means that Register 10₁₆ will be broadcast at the start of transmission, and a second time after 18s when the bit will be reset to 0. Ground Stations will extract the broadcast, will analyze the content, will see that the start indicator is set and will reinitiate all protocols.

5.0 Conclusion and way forward

ICAO ASP TSG prefers Option 4 as it provides a means to protect all protocols including data-flash without interfering with other protocols as FS and DR do. However it will not be available on transponder Level 1.

SC-209 is invited to discuss the different options and to consider the feasibility of the proposed approach proposed by ICAO ASP TSG consisting in the addition of a specific bit in Register 10₁₆ (e.g., Bit 10) which will be set for 18s after a transponder has left the off or stand-by state in order to trigger a broadcast of Register 10₁₆ at start-up of transmission.