RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #17

Teleconference on 11.06.03

Requirements for Processing Overlapping Synchronization Triggers: Part II

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SUMMARY

This paper addresses an issue that arose during Meeting 16 of WG5. Working Paper UAT-WP-16-02 pointed out that the UAT MOPS did not adequately test the capability of receivers to process "triggers" occurring at a high rate in scenarios with overlapping signals. The issue was not resolved during Meeting 16. This working paper suggests a new requirement and a new test procedure that addresses this issue.

Larry Bachman, Tom Mosher, Tom Pagano and Ed Valovage have had an opportunity to review the material in this draft.

Introduction

A recent paper submitted to SC186 WG5 (UAT-WP-16-02) has raised the issue of whether or not there should be an addition to the UAT MOPS (DO-282) to cover minimum requirements for processing synchronization trigger events at a high rate. The issue was unresolved at the sixteenth meeting of WG-5 held on 17 September 2003. This paper attempts to clarify the current status of the UAT MOPS related to this issue and to suggest a scheme for adding an appropriate requirement.

Note that the method of testing need not require the creation of an exact replica of the LA2020 and/or CE2015 incoming message environments. To do that would require an elaborate and perhaps impractical test capability. Instead, the tests should take advantage of the extensive simulation work that has already been done. By testing a suitably chosen set of key receiver attributes, a very high level of confidence that the complete receiving system will work as required can be attained.

Background

The ADS-B message reception process consists of a number of steps. These include synchronization (triggering), message decoding, and report generation. Each of these processes should have a specification for performance vis-à-vis individual messages and a specification for the rates at which the processing must be performed. Table 1 shows that most of these areas are already covered in the current MOPS. The one area that is not covered is the rate at which the receiver must process trigger events. Some suggested requirements are included in square brackets.

Table 1: ADS-B Message Processing Requirements

	Process			Equipment Class
	Synchronization* (Trigger)	Decode Processing	Report Generation	
Logic	2.2.8.3.3	2.2.8.3.1.1	2.2.10.3	All
Cochannel Performance	2.2.8.2.5	2.2.8.2.5	N/A	All**
Rate (per second)	[2.2.8.2.7]	2.2.10.2***	2.2.10.3	
	[1000]	700	650	A3
	[1000]	700	500	A2
	[1000]	700	500	A1H
	[900]	600	300	A1L
	[900]	600	200	A0

*Bracketed numbers are proposed in this WP.
**There is a special cochannel requirement for A3.
***Support for these numbers can be found in UAT-WP-11-18.

WP-16-02 presented the results of a simulation that showed that the maximum number of synchronizations for an A3 receiver in the LA2020 and CE2015 scenarios was no more than 1000 per second, with the average being about 930 per second. (It is interesting to note that when the simulation method described in UAT-WP-10-01 was amended to include a 9 dB cochannel requirement, it also estimated an average synchronization rate of 930 per second. Another interesting outcome of that simulation was that the average synchronization rate rose to about 1125 per second when the cochannel requirement was changed to 4 dB, which is the value that applies to all but the A3 Equipment Class.) WP-16-02 also estimated that the maximum rate of synchronizations for A0 receivers was about 900 per second. These results are the rationale for the numbers in square brackets in the table.

Recommendation

It is recommended that a new section be inserted into the MOPS as follows:

2.2.8.2.7 Trigger Processing Rate

Receiver trigger processing rate requirements are as follows:

a. A3, A2, and A1H receivers **shall** be capable of successfully processing at least 1000 trigger events per second.
b. A1L and A0 receivers **shall** be capable of successfully processing at least 900 trigger events per second.

This new requirement will also lead to a new test procedure. It is recommended that a new section numbered 2.4.8.2.7 be added to the test section of the MOPS. Based on the fact that the simulations have shown that the majority of trigger events involve no overlaps or single overlaps (see, for instance, UAT-WP-10-01), it is not necessary to create double overlaps for this test. Such cases are adequately covered in 2.4.8.3.3. Also, it is not necessary to create explicit cases of "embedded synchronization." If the payload is provided by a suitably chosen random number generator, the analysis of section H.5 of Appendix H shows that about 5% of the message payloads will automatically lead to the phenomenon.

Note that the signal levels suggested below (S_1/S_2 = 15 dB) are expected to cause the message success rate (MSR) for the larger signals to be nearly 100% and the MSR for the smaller signals to be nearly 0% in cases where they overlap. To allow for unlikely events, the suggested success criterion is reduced to 99%.

Suggested wording of the test procedure section is as follows:

Desired Message Signals:

Provide a method of supplying the UUT with two sources of desired Long ADS-B Messages. Each signal source generates messages according to a periodic schedule based on a 28 MSO period for Equipment Classes A3, A2 and A1H and a 24 MSO period for Equipment Classes A1L and A0. For each Equipment Class the period must be repeated exactly 101 times each second. The contents of the messages are as follows:

Message Contents for All Message Sources:

- Payload Type Code = 1
- Address Qualifier = 0
- ICAO Address: See below
- Payload is filled with pseudorandom data. The pseudorandom generator should have a long enough period so that no data is repeated during the course of the test.

  Note: It is acceptable to employ a limited a set of "canned" messages based on pseudorandom number generator. The number of stored messages should be somewhat larger than the number of messages required for a second's worth of testing. If the number of each type of stored message is prime with respect to the number of messages needed each second, the overlap between to two sources will be randomized on a second-by-second basis.

- Valid FEC parity is provided.

Transmission Schedule and Power Level for Each Message Source:

For A3, A2 and A1H

Message Source	Tx Schedule (MSO within each 28 MSO period)	ICAO Address	Power Level (dBm)
1	0, 4, 8, 12, 16, 20, 24	0x000001	-80
2	5, 13, 21	0x000002	-65

For A1L and A0

Message Source	Tx Schedule (MSO within each 24 MSO period)	ICAO Address	Power Level (dBm)
1	0, 4, 8, 12, 16, 20	0x000001	-80
2	5, 13, 21	0x000002	-65

In each case the beginning of the first transmission period is MSO = 752. (This causes all the ADS-B messages to fall within the ADS-B segment of each second.)

For A3, A2 and A1H observe that the UUT reports reception of at least 400 messages with ICAO address 0x000001 and at least 300 messages with ICAO address 0x000002 per second.

For A1L and A0 observe that the UUT reports reception of at least 300 messages with ICAO address 0x000001 and at least 300 messages with ICAO address 0x000002 per second.

In this suggested test procedure, it is expected that *all* of the messages will result in successful triggers. All the messages from Source 2 are expected to cause successful decodes. The messages from Source 1 that begin at MSOs 4, 12 and 20 are expected to fail since they will have substantial overlap with stronger signals from Source 2. Each of the successful decodes will entail one Reed Solomon decode process, and each unsuccessful decode will entail two Reed Solomon decodes since the receiver will need to attempt a Basic ADS-B decode after the Long ADS-B decode process fails. Also, about 5% of the successful messages may contain "embedded synchronization" patterns that will fail after two Reed Solomon decodes. Thus, for A3, A2 and A1H the number of Reed Solomon decode attempts per second will be about 1182 (= 707 + 2*202 +0.05*2*707). For A1L and A0 the number of Reed Solomon decode attempts per second will be about 1071 (= 606 + 2*202 +0.05*2*606).

Note that the numbers in the proposed Section 2.2.8.2.7 for A0 and A1L are only slightly lower than the numbers for the other Equipment Classes; it may be desirable to set the same requirement for all the classes in the interest of simplicity.