RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #4

NUMBER OF BITS for GROUND STATION ID

Presented by Ed Valovage, Sensis Corporation

SUMMARY

This is a reply to action item 2-18. Some thoughts are given for anti spoofing, division of uplink labor, TIS-B/ADS-B fusion, and time slot dithering. The conclusion is to use 5 bits for ground station ID and tie the assignment to the assignment of transmit time slots.

ACTION ITEM 2-18:

Recommendation on whether to use 5 or 6 bits for ground station identification, including rationale taking into account needed anti-spoofing, and division of uplink labor between ground stations. We need to support TIS-B/ADS-B fusion, if possible.

The question has mainly to do with a TIS-B message. Uplinked traffic reports will have a "few" bits of station ID information to indicate their source. How many? Since there are a large number of TIS-B reports, we need to use a minimum of bits. There are two directions of thinking.

1) ***brute force assurance that it will be unambiguous at the receiving aircraft:*** Use max range and determine how many ground stations can be in view. Rough numbers as point-of-reference: -93 dBm receiver, 250 watt transmit power, 0 losses, 0 dBi antennas yields 240 nmi. range. This is line-of-sight for altitude of 38,000 feet. PROBLEMS: in non-flat terrain, may be even farther. Same is true for anomalous propagation. Answer is about 85 ground cells with a 60 nmi hexagonal grid. This requires 6.4 bits. More than we are willing to give up (6 max).

2) ***tie the geographic re-use of time slots to the re-use of ground station ID codes:*** The time slots (there are 32, or 5 bits worth) will be allocated in different ways depending on the geography and the particular requirements of the application. In any case, there will be some way of assuring that the interference will not occur or will be tolerable. The ID code has similar issues. If ground stations with the same ID code transmit in the same time slot, the receiver will in general receive the closer one. Occasionally it will receive neither (due to the interference) or will receive the farther one. The worst that will happen in the latter case is that the TIS-B report will not be in an area of interest to that aircraft. The traffic plot will always be correct.

Why have any ground station identifier for TIS-B reports? The reports contain unambiguous lat/long and will be plotted on the aircraft display in the proper location, so the basic function does not require ground ID. But the ground ID can help with anti-spoofing and as a rough health check on the aircraft's own position report, both accomplished by computing propagation time. To be more specific on this, the location (lat/long) of each station is included in the FIS-B uplink header along with the station identifier. This gives the correlation between identifier and position (for the strongest station with that identifier). This is verifiable by propagation time. Subsequent TIS-B reports can have their propagation times compared to this for consistency.

Some more thoughts on spoofing: Spoofing should be considered in an analysis exclusively on the topic. The result should be a description of the spoofing attempts to which the UAT protocol is immune (or can be if certain algorithms are implemented in the hardware) and those to which it is vulnerable (there will always be something). For the case of the unauthorized transmitter of TIS-B information, a propagation time check (if implemented) will catch a spoofer transmitting a given ID but from the wrong location. If he is also transmitting his actual location in a FIS-B header, it can still be caught if there is a database of authorized stations, otherwise it is not caught.

As for division of uplink labor between ground stations, we can again lean on the idea that there will be a variety of approaches for ground station spacing, power, and time slot re-use as well as sharing. These will determine the division of labor.

TIS-B/ADS-B fusion is another area of many possibilities. We do not have to decide or specify how it is done, but we do have to be sure that the desirable schemes can be supported. As long as all TIS-B uplinked targets have an ID (equivalent to ADS-B) I believe fusion is fairly simple. One example is for the aircraft display to plot, at its own update rate, the report with the latest time-of-validity for each unique target. If it is desirable to include ground station ID in the decision to combine targets, this is still supported with the 5-bit identifier up to the every-32-cell ambiguity.

One other topic is time slot "dithering" to avoid constant interference of one ground station by another system, which is also synchronized to the UTC second. A fairly simple scheme involves a "rotation" of time slots, wherein each station transmits one time slot later every second (wrapping back to the first after using the last one). The station starts with an assigned slot at the "top of the hour" or first second of the day. Since everybody knows what time it is, the time slot offset is known and can be factored in to the propagation time analysis. A random approach, as used for the airborne platforms, is not necessary since, unlike the aircraft, which come and go and move around, the ground stations are fixed and can be assigned time slots in an organized manner.

Wrapping all of this together, we should allocate 5 bits to the ground station identifier and tie it to the time slot re-use scheme.

Outline for discussion:

Two approaches: brute force and tie to time slot allocation

Why have any ID

Spoofing

Division of uplink labor

TIS-B/ADS-B fusion

Time slot dithering

Conclusion: 5 bits