## RTCA Special Committee 186, Working Group 3

## ADS-B 1090 MOPS, Revision A

## Meeting #10

# Proposed Transmission Rate for ID Squitter

**Presented by William Harman**

SUMMARY

MOPS changes are being considered for implementation of proposed changes to the ADS-B MASPS. The proposed changes include a substantial increase in information content for Intent communications, and also increases in the required communications rates. One possible way of supporting these increases might be as an exchange for a reduction in the transmission of ID Squitters. A current Action Item (9-2) calls for use of an existing track-level simulation to investigate the effect of ID transmission rate. This paper presents simulation results showing how track establishment is affected by the transmission rate of ID messages. While the work on this Action Item is not complete, this paper presents the current status of the work and results.

**Transmission Rate for ID Squitter**

William Harman

MOPS changes are being considered for implementation of proposed changes to the ADS-B MASPS. The proposed changes would include a substantial increase in information content for Intent communications, and also increases in the required communications rates. One possible way of supporting these increases might be as an exchange for a reduction in the transmission of ID Squitters. We have been using a track-level simulation to investigate the effects of ID transmission rate on ADS-B performance. This simulation assesses the establishment of a new ADS-B track, which is defined to include the detection of a new target, determining its location (globally unambiguous), and determining its velocity, ID, and the content of the Status and Intent messages.

The simulation is formulated as an encounter between two aircraft flying in opposite directions, both at 600 knots, with a horizontal offset of 5 NM, as illustrated in Figure 1. This is a Monte Carlo simulation in which the encounter is simulated a large number of times, using pseudo random conditions for antenna gain values and other power parameters as well as for interference effects. One aircraft is designated as the transmitting aircraft, and the other as the receiving aircraft. The transmitting aircraft is equipped to transmit all of the defined message types, including position, velocity, ID, Status, TCP, and TCP+1. After running a large number of encounters, surveillance performance is assessed by the percentage of encounters for which performance was satisfactory according to the standards given in the ADS-B MASPS.

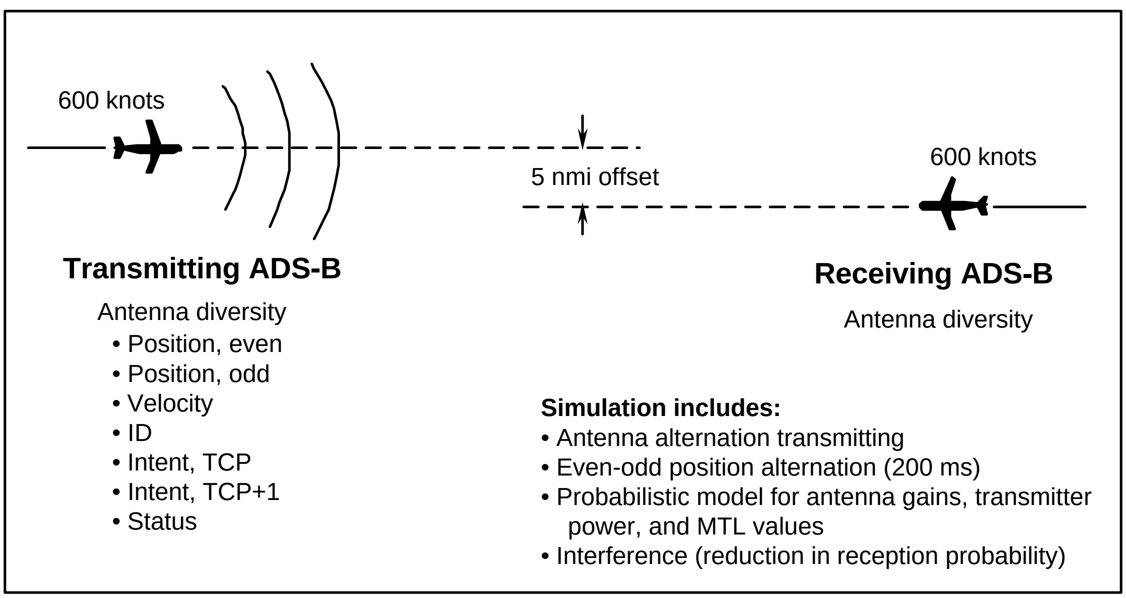


Figure 1. Formulation of the simulation.

Currently the simulation is set up for the rate of ID transmissions equal to one transmission per 2.5 seconds. We are considering changing this rate to one transmission per 5 seconds. The current transmission rates of the different message types can be summarized in the following table and in Figure 2.

| | |
|---|---|
| **Velocity** | **2.0 / sec.** |
| **Position** | **2.0 / sec.** |
| **ID** | **1/2.5 = 0.4 / sec.** |
| **Status** | **1/1.7 = 0.6 / sec.** |
| **TCP** | **1/1.7 = 0.6 / sec.** |
| **TCP+1** | **1/1.7 = 0.6 / sec.** |
| **total** | **6.2 / sec.** |

**This is the maximum allowed by ICAO.**

## Extended Squitter Transmission Rates

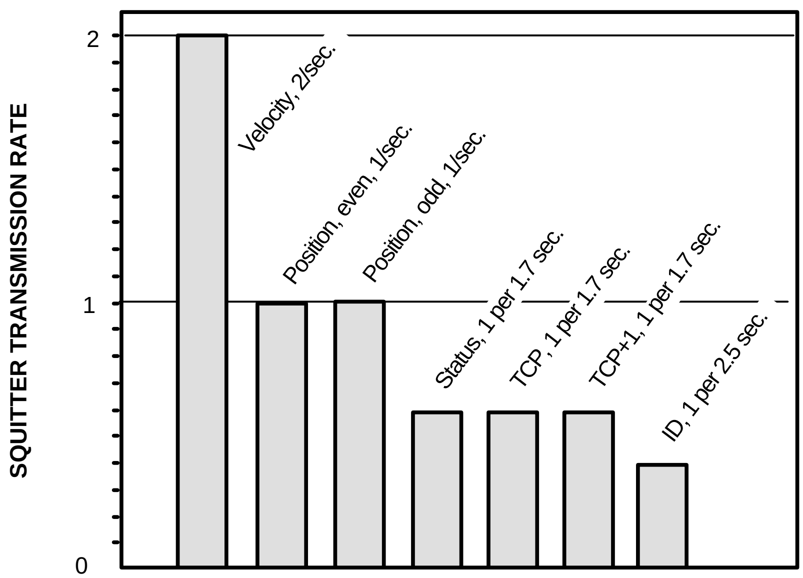


Figure 2. Squitter transmission rates.

Note that ID has the lowest transmission rate, even before the contemplated change which would reduce it rate by a factor of 2.

Simulation results are given in Figure 3, for a high interference case

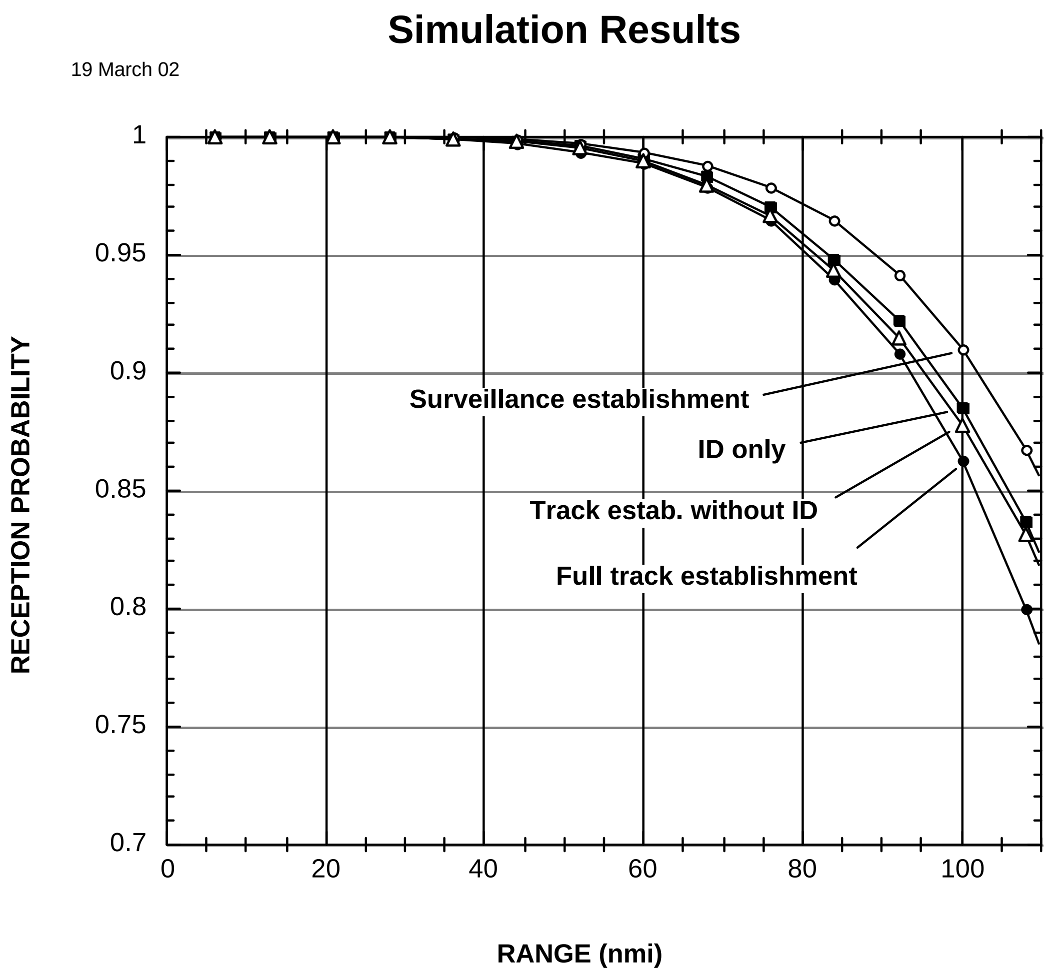


Figure 3. Simulation results.

The left-most curve is the probability of track establishment, including all of the message types. Track establishment is further defined to require both even and odd position messages to be received within a 10 second period.

With these results in mind, the reason for setting up the study for converging aircraft may be appreciated. For track establishment at some particular range, 60 NM, for example, ID reception would be essentially 100% probable if the range remained 60 NM for a long period of time. But converging aircraft present a more demanding scenario, in which the duration during which ID can be received is limited by the time it took before reaching 60 NM range. Therefore, closing at high rate is the most demanding configuration for track establishment. It was the difficulty in calculating the cumulative probability of reception that motivated the development of this simulation.

In addition to the full track establishment performance shown in Figure 3, other less complete levels of performance are also shown. The next curve on the right is for track establishment without requiring ID reception. The third curve shows the reception performance for just ID. Finally, the curve on the far right shows establishment of a surveillance track, including both position and velocity.

From these results, we can begin to assess the manner in which ID reception, and the underlying ID transmission rate, affect performance. The curves are seen to be remarkably close together. Full track establishment with 95% reliability is seen to occur at a range of 81 NM. If the criterion for track establishment were relaxed by not requiring ID, the 95% range would be nearly the same, about 82 NM. The complementary case is reception of ID while not requiring any other information. For this, the 95% range would be 84 NM.

We were interested to compare the two complementary cases, with and without ID. Note that multiplying the two probabilities yields the following values (for range = 81 NM),

$$P(\text{track estab. minus ID}) \times P(\text{ID reception}) = (0.952) \times (0.958) = 0.912$$

whereas

$$P(\text{full track establishment}) = 0.95$$

If these two conditions were statistically independent, their product would equal P(establishment). Seeing the difference indicates that they are statistically dependent, which seems reasonable when considering the differences in power fading from encounter to encounter. In other words, when track establishment is complete except for ID reception, this is often because the power conditions are favorable. Under those conditions, it is more likely that ID will be received.

This simulation work is not yet complete but is progressing well. We prepared this working paper to show the status of the work and the types of simulation outputs that are being obtained. The initial results suggest that, although the current ID transmission rate is relatively low, it will likely be possible to reduce it and still achieve good system performance.