RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #14

Action Item 13-04
Transmitter Power for Class B2

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SUMMARY

Class B2 vehicles, such as snowplows, will broadcast but not receive. In one application being considered by WG-3, these transmissions may be received by aircraft on approach to land at that airport. In the event that the transmitting snowplow is located on the same runway where the aircraft is planning to land, the surveillance information would help to alert the pilot to the conflict, and avoid a serious accident. The question of what transmitter power to use for these transmissions was discussed at the previous meeting. It was pointed out that the range between transmitter and receiver is relatively small, so a lower transmitter power might be sufficient. A study was requested to determine reception performance as a function of range, for ranges of 10 NM and less. This study was performed using a simulation. The results are presented in this Working Paper. This study addresses Action Item #13-04.

Transmitter Power for Class B2

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FORMULATION OF STUDY

A simulation was performed to determine reception performance as a function of range, for different values of transmitter power. The first case considered was for a 70 watt transmitter, and the following other specifics.

- The transmitter is a snowplow
- Transmitter power = 70 watts at antenna
- Single transmitting antenna on the snowplow
  Normal omni antenna, like an aircraft antenna
- Transmission rate = 2 positions/sec. and 2 velocities/sec.
- The receiver is a landing aircraft having enhanced reception
  (Class A2 or A3)
- Receiver MTL = -84 dBm.
- The receiving aircraft has top-bottom antenna diversity and both are useful
  Aircraft pitch is not considered in this case.
- Interference environment is based on Frankfurt, maximum current aircraft density (30,000 ATCRBS fruit/sec.) plus Mode S interference resulting from Extended Squitter. The interference effects are summarized in Figure 1, which shows reception probability as a function of range. This was taken from the recent European report (ref. 1, Figure 6, on page 97).

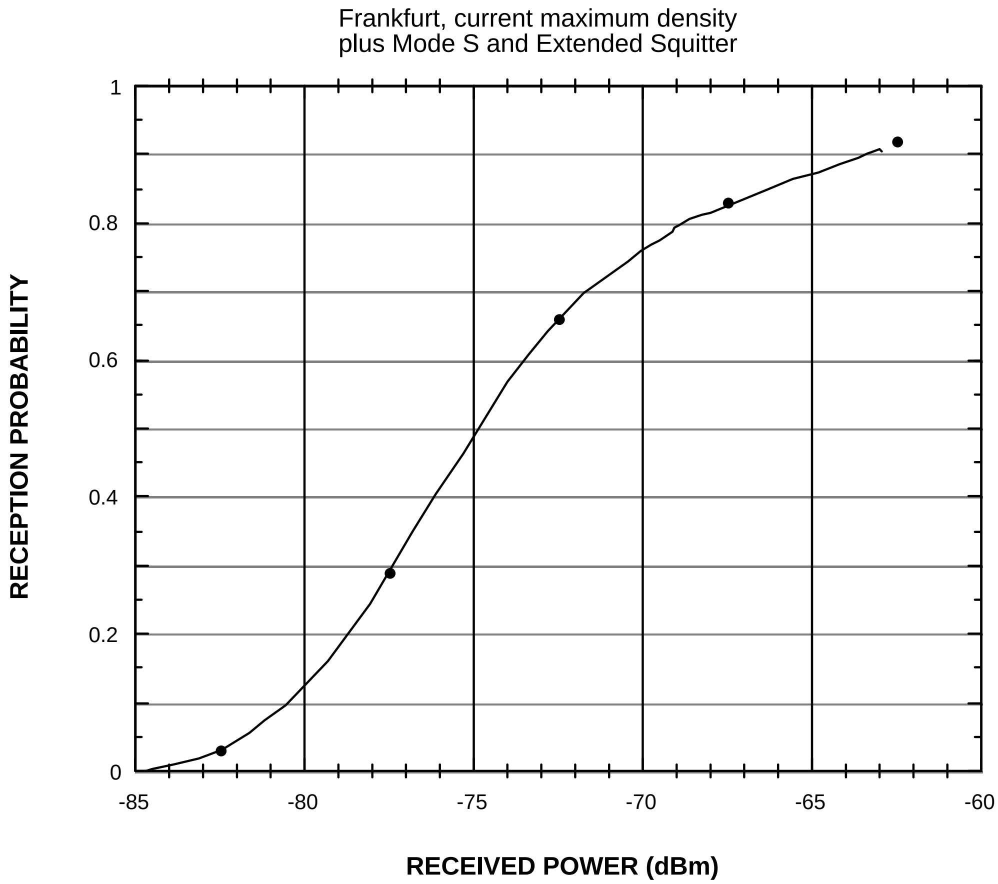

Figure 1. Reception probability as affected by interference.

Subsequent cases addressed different values of transmitter power, Class A1 aircraft reception, and aircraft pitch, which can degrade the top antenna reception.

The formulation of this analysis was the same as the analysis described in the European report (ref. 1). The interference environment is characterized by a curve of reception probability as a function of received power level, taken from ref. 1, Figure 6 (page 97). Relative to that previous analysis, the case here is simpler because the transmitter power is a single value rather than a variable, and because the transmitter has one antenna rather than two. To model the antenna gain of the transmitting antenna, the statistical model used by TLAT air aircraft antennas was used.

PERFORMANCE CRITERION (T95/95)

Reception performance is characterized by the Update Time, called T95/95, which is defined as follows. For a given transmitter-receiver pair and a particular range, performance will depend on the received power level, and therefore on the antenna gains. Performance is a monotonic function of received power level, so we focus attention on the received power level that is exceeded by 95% of all transmitter-receiver pairs. For that power level, we determine the reception probability, and from that determine the update time for which surveillance update is 95% likely. The results is called T95/95. A surveillance update is considered successful when either a position message is received or a velocity message is received. Reference 1, Appendix B explains why this criterion is appropriate for Extended Squitter surveillance.

RESULTS

The results in this initial case are given in Figure 2, which is a plot of update time T95/95 as a function of range.

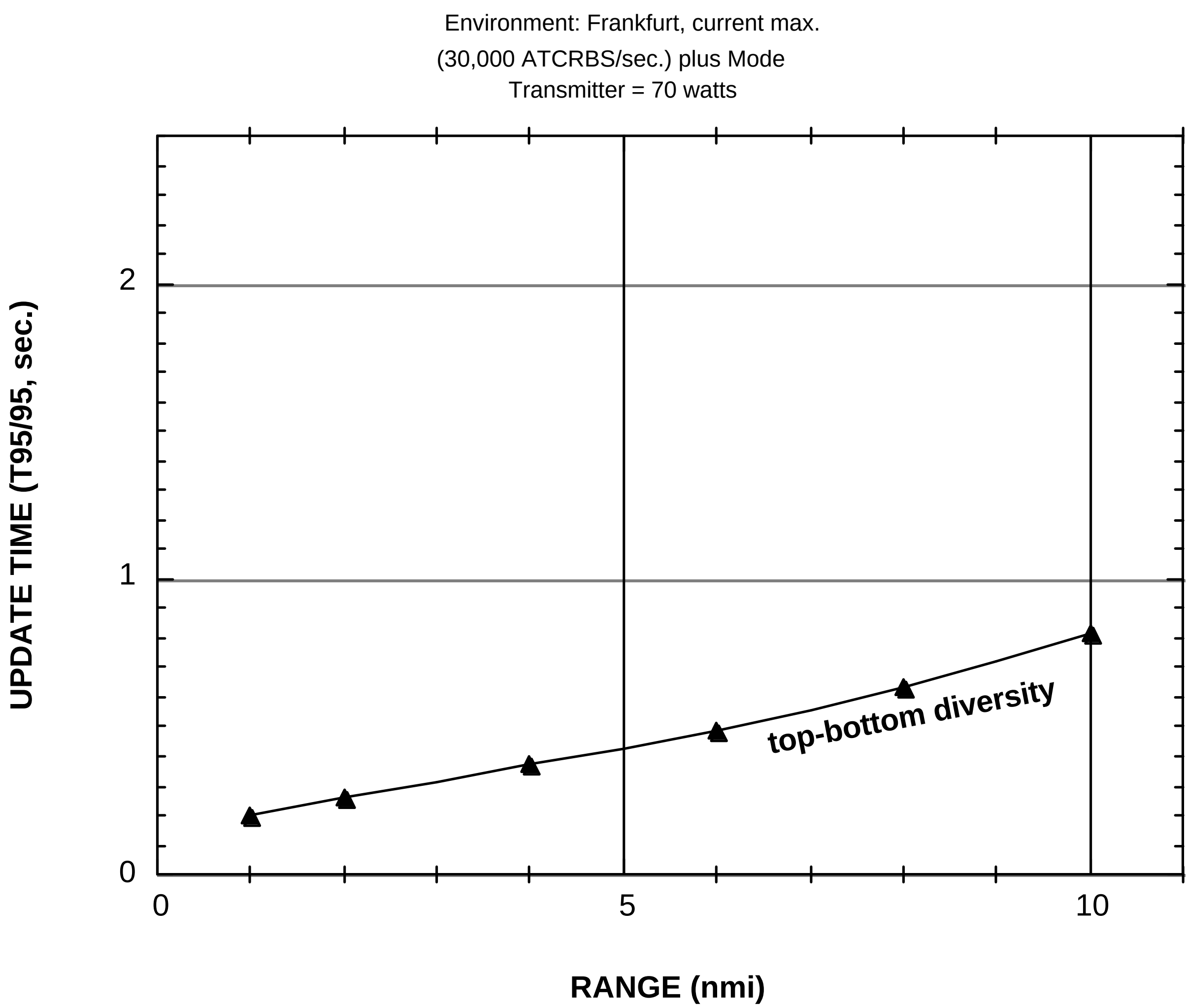

Figure 2. Reception performance, snowplow to landing aircraft.

The performance shown in Figure 2 is quite good. Even at 10 NM range, the (95%-95%) reception update is better than 1 second, and performance improves as range decreases.

The next case considered is similar, except that pitch of the landing aircraft is considered, assuming that top antenna receptions are not useful. To represent this in the simulation, the top antenna was modeled as having gain = -10 dB, and the bottom antenna was modeled the same as in the initial case. This model is not quite realistic, because the upward pitch would also be expected to increase the gain of the bottom antenna. That beneficial effect was not included in this study.

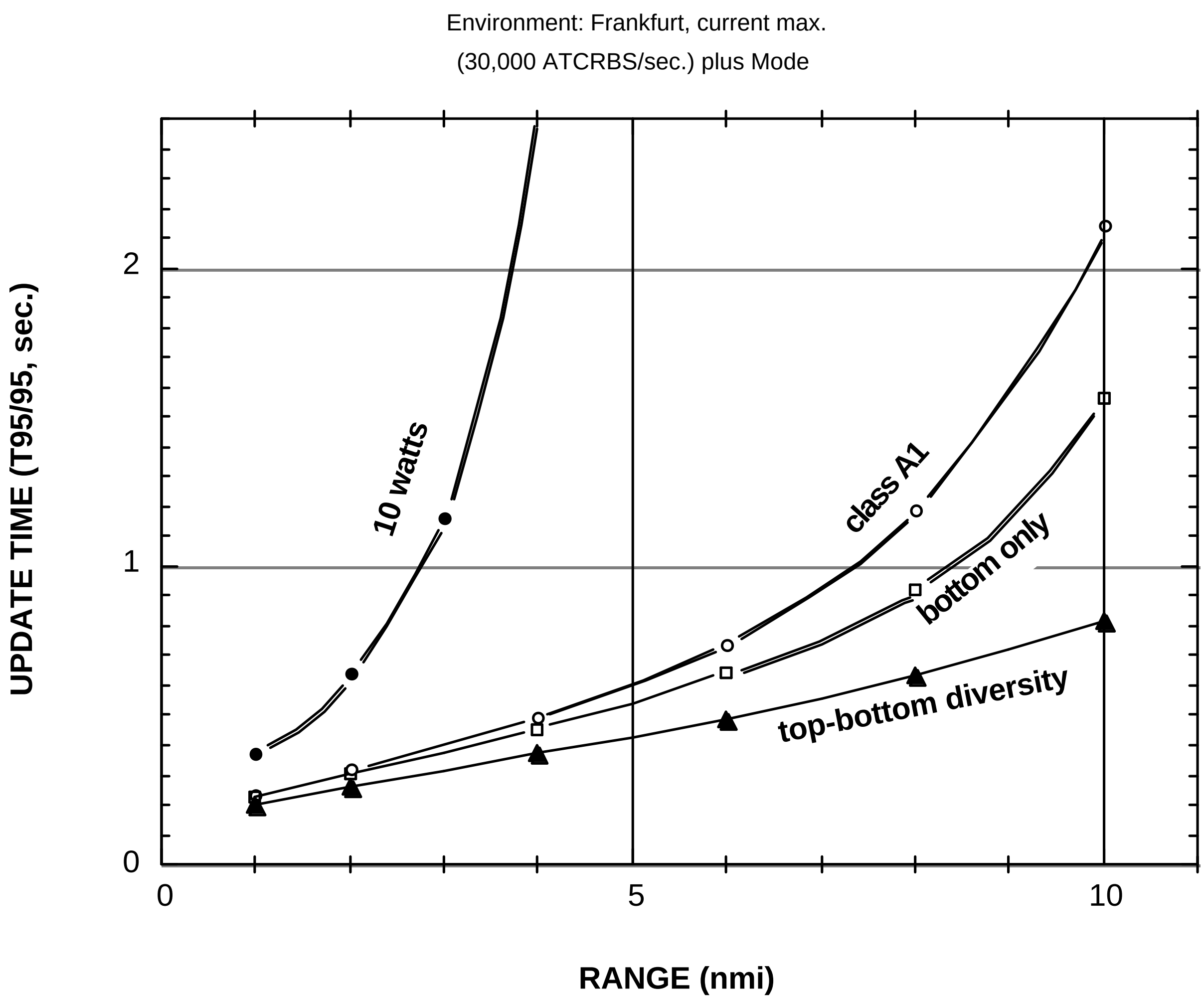

Figure 3. Reception for several cases.

The results are given in Figure 3, along with results from several other cases. The other two cases shown in Figure 3 are as follows.

"Class A1". For the curve marked "class A1", the case is the same as the "bottom only" case, except that the receiver uses the center-sample technique rather than the baseline enhanced technique. We ran the pulse level simulation for this case, and found that performance, in the form of reception probability as a function of received power level, was degraded by about 1 dB. In the analysis for Figure 3, this change in receiver performance was calculated using a 1 dB degradation.

10 Watts. For the curve marked "10 watts", the case is the same as the "class A1" case, except that the transmitter power is reduced to 10 watts. The resulting performance was calculated simply by reducing range by a factor:

$$\text{Factor} = \text{sqrt}(10/70)$$

SUMMARY

Having calculated the snowplow to aircraft performance for four cases, the results indicate that performance is quite good if the transmitter power is 70 watts. If the transmitter power were reduced to 10 watts, performance would degrade significantly.

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Reference 1. "1090 MHz Extended Squitter Assessment Report," FAA and EUROCONTROL Experimental Center, June 2002.