RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #15

Action Item 13-04
Transmitter Power for Class B2

Presented by William Harman

SUMMARY

Class B2 vehicles, such as snowplows, will broadcast their positions but not receive. In one application being considered by WG-3, these broadcasts may be received by aircraft on approach to land at that airport. In the event of an operational error in which the transmitting vehicle is located on the landing runway, the surveillance information would alert the pilot to the conflict, which could avoid a serious accident. The question of what transmitter power would be appropriate for these broadcasts was discussed at the previous two meetings. To support the discussions, Lincoln Laboratory is making performance assessments for several possible values of transmitter power. The results are presented in this paper. This addresses Action Item #13-04.

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I presented initial results at the previous meeting. During the discussion it was realized that those results contained an error. They did not take into account the fact that the Extended Squitter format for vehicles on the surface includes position and velocity in a single squitter. Therefore the total surveillance transmission rate is 2 per second rather than 4 per second. This error has now been corrected, and the new results are presented in this paper.

We have also extended the analysis to include acquisition as well as surveillance updates. The acquisition process, which happens as squitters are initially received at the aircraft, requires reception of both an even-format message and an odd-format message. The time limit for even and odd receptions is 10 seconds for airborne transmitters. This is proposed to be changed to 100 seconds in another working paper at this meeting (paper #11). The 100 second time limit was used in this analysis.

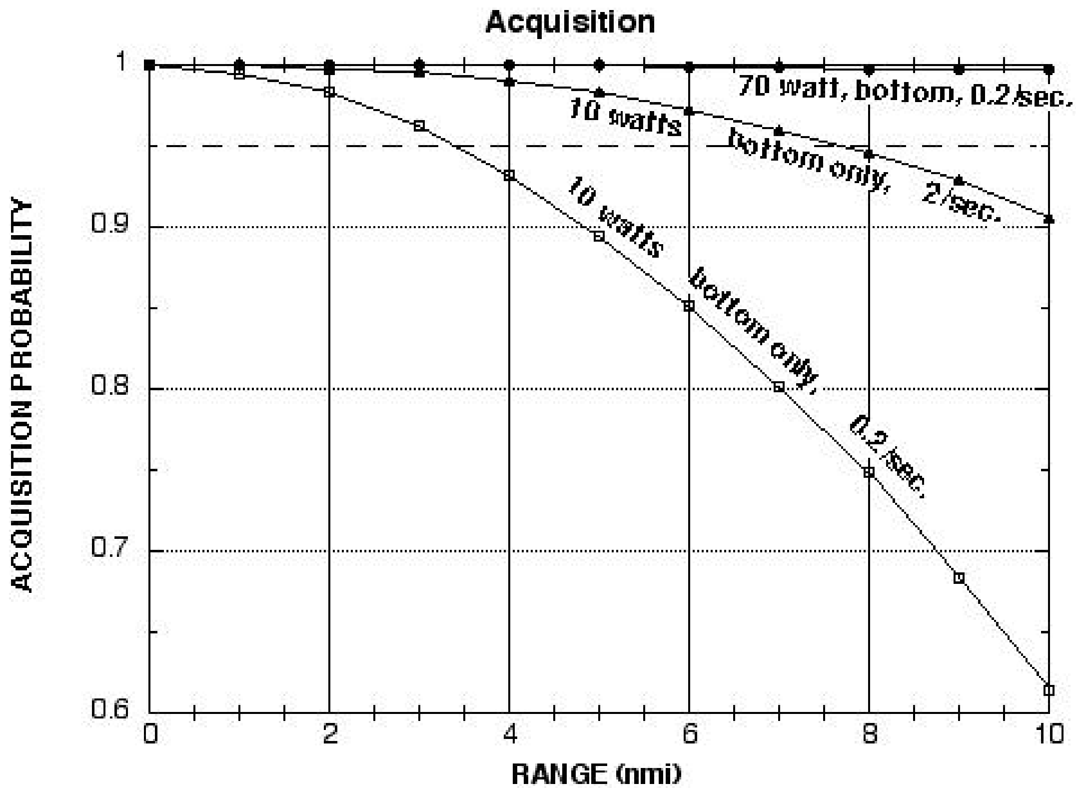
CASES CONSIDERED

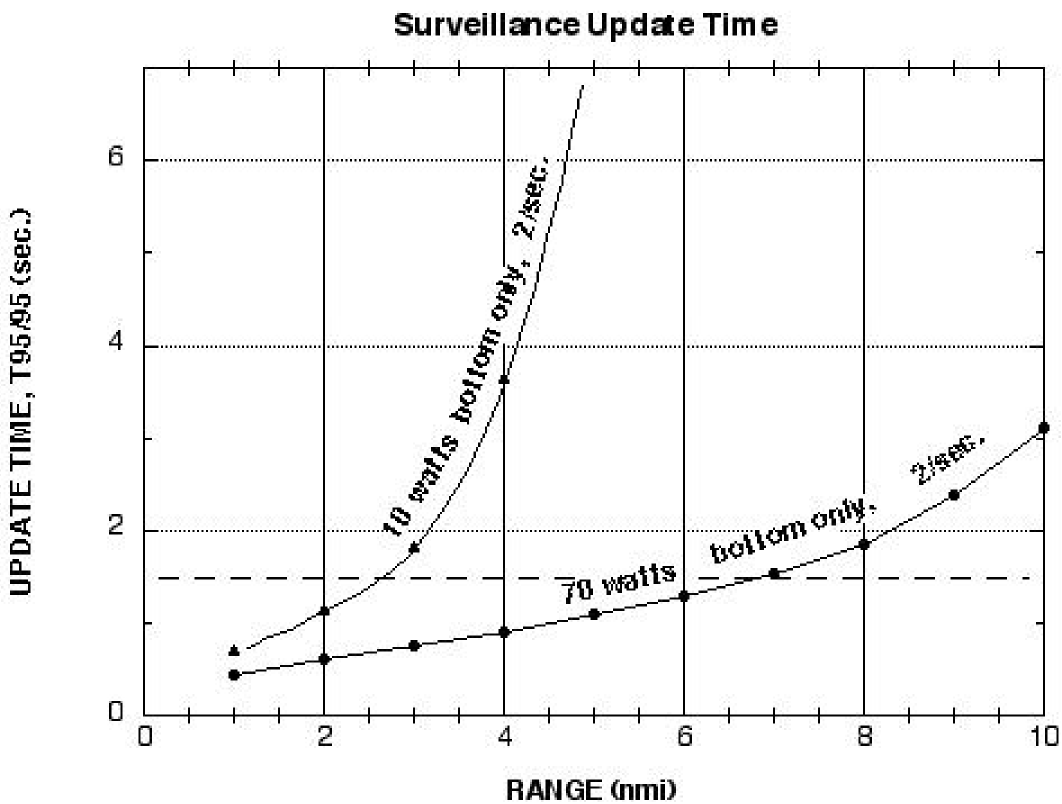
Both acquisition and surveillance update performance were assessed for several cases of transmitter power and rate. Transmitter power was assigned 70 watts in some cases and 10 watts in others. The transmitting vehicle was characterized by a single antenna, having antenna gain values characterized by the statistical distribution of an aircraft antenna. We used the TLAT antenna model, which is a bell shaped distribution having mean = 0.5 dB and standard deviation = 2.7 dB. The aircraft was modeled as having top and bottom antenna diversity, but with an upward pitch such that the top antenna was not useful. Therefore the model for the aircraft was a single bottom mounted antenna. The assessment applies to a high interference environment. Specifically it applies to the maximum interference measured in Frankfurt (30,000 ATCRBS fruit per sec.) increased to include Mode S interference, both short and long formats, transmitted by all aircraft [Ref. 1].

ACQUISITION

We used a Monte Carlo simulation to determine the acquisition performance for the two values of transmitter power and for two transmission rates, 2 per second and 0.2 per second. The transmitting vehicle was stationary, and the aircraft was landing at a constant speed of 150 knots, which is somewhat higher than typical landing speeds. We began the simulation when the range was 20 NM.

The results are shown in the accompanying figure, in the upper plot. For all of the scenarios in which the transmitter power = 70 watts. acquisition performance was nearly 100% by the time the range reached 10 NM. When the transmitter power was reduced to 10 watts, acquisition was not as reliable at 10 NM, but improved as range decreased. As shown in the figure, acquisition improved to 95% at a range of about 7.5 NM, for a transmission rate of 2 per second.


Acquisition
ACQUISITION PROBABILITY
RANGE (nmi)
70 watt, bottom, 0.2/sec.
10 watts bottom only, 2/sec.
10 watts bottom only, 0.2/sec.
1
0.9
0.8
0.7
0.6
0
2
4
6
8
10


Surveillance Update Time
UPDATE TIME, T95/95 (sec.)
RANGE (nmi)
10 watts bottom only, 2/sec.
70 watts bottom only, 2/sec.
6
4
2
0
0
2
4
6
8
10

Performance was also assessed for the lower transmission rate of 0.2 per second, and the results are shown in the figure. Performance reaches 95% at a range of about 3.5 NM.

SURVEILLANCE UPDATE RATE

After the surveillance track has been acquired, it must be updated to indicate any motion of the vehicle. We performed the surveillance update assessment as presented in the previous meeting, correcting the error of the transmission rate.

Update 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 result is called T95/95.

Performance results are presented in the accompanying figure, in the lower plot. For comparison, these two plots are shown together, using a common range scale. The results indicate that surveillance updates are the more demanding process.

If we use a criterion that T95/95 should be 1.5 seconds or less, as is suggested in Mark Schneider's paper (#17), then surveillance performance satisfies this criterion at a range of about 2.5 NM and from that point on.

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