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Appendix P Material Clarifications

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SUMMARY

Among the Action Items being addressed at the Paris meeting, one topic is a presentation of recent performance evaluations of 1090ES in future high-density areas, for possible inclusion in Appendix P of the MOPS. With reference to Working Paper 1090-WP28-04 by Larry Bachman, this Working Paper offers some clarifications, intending to help indicate the assumptions that were used. This Working Paper also presents some evaluation results generated by Lincoln Laboratory for comparison with the values given in 1090-WP28-04. In developing DO-260A it was useful to present evaluations by both Johns Hopkins APL and M.I.T. Lincoln Laboratory. To the extent that the results agree, that comparison helps to indicate confidence in the validity of the results.

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Four Futuristic Environments

1090-WP28-04 presents performance estimates for four futuristic interference environments, called:

Environment A
Environment B
Environment C
Environment D

It might be helpful to provide more of a description of how these four environments compare with high-density measurements in the New York and New Jersey airspace. The following table provides more specifics underlying the four environments.

	DATE	NUMBER OF AIRCRAFT WITHIN 100 NM	Normalized Aircraft Density	Assumed growth rate (% per year)
Measured	2007	384	1	-
Environment A	2020	539	1.40	2.6
Environment B	2025	653	1.70	3.0
Environment C	2030	794	2.07	3.2
Environment D	2035	952	2.48	3.3

In other words, these four environments were intended to project in the future as far as the year 2035. In allowing for future growth in airborne aircraft, it was assumed that the density of aircraft in an area that is currently quite dense, would increase by exponential growth at a certain percentage per year. After compounding the increases over that number of years, the total would be as high as 2.48 times as dense as the value measured in 2007.

When this study was done, it was originally thought that the exponential growth would be between 3 and 4 percent per year. Since that time, the FAA has published a current estimate of traffic growth, which has a rate of 1.7 % per year. Therefore the current FAA projections into the future are not as high as the assumptions used in this study.

Environments A, B, C, and D were also defined under the assumption the Terra mode would not be used by the year 2020, and also that the radar interrogation rates for All-Call interrogations will have been reduced by 2020.

Performance Evaluation

Lincoln Laboratory is participating in the high-density performance evaluation program referred to in the paper 1090-WP28-04, and has generated results for the four environments, A, B, C, and D. Those results for class A3 avionics are summarized in the following table for the 20 NM case, in which the ADS-B requirement is that the Nominal Update Interval is 7 seconds or less.

		Nominal Update Interval	
	Aircraft Density (normalized*)	Results in WP28-04 (sec.)	Lincoln Lab. Results (sec.)
Environment A (2020)	1.40	4	2
Environment B (2025)	1.70	6	3
Environment C (2030)	2.07	12	4
Environment D (2035)	2.48	20	6

* The normalization applies to aircraft density measurements in 2007.

We realize that there is a substantial difference in the results from the two methods of evaluation. Work is on-going to resolve the differences with the goal of converging on methods and results that are consistent.

Recent discussions on that subject suggest that the difference may be largely due to different assumptions about a tracker in the receiving aircraft. The Lincoln evaluation applies to receiving aircraft who's ASSAP includes a tracker, which seems reasonable by 2020. All receptions, whether position or velocity, are provided to the tracker, and all are used by the tracker. The output of the ASSAP provides time registered position and velocity at any time for use by applications.

Other Notes

In making aircraft density predictions to 2035, it's important to realize any predictions that far into the future cannot be made confidently. It is useful to consider very high density conditions to help make preparations for conditions that could possible occur. Of course, the fact that very high aircraft densities are being considered is not the same as predicting that such high densities will actually occur. It should also be kept in mind that the number of airports and runways built between now and 2035 will surely not be as high as the 2.48 factor used here. On the other hand, it seems possible for aircraft density to grow faster than the number of runways if ADS-B becomes more and more effective in supporting new techniques that allow higher aircraft density.

It should also be noted that the FAA's formal projections for growth into the future pertain to total flights, not to the number of aircraft airborne at any one time. One acknowledged technique to handle increases is to extend the hours of operation, or generally to increase the rate of use during off-peak times of day.

It should also be noted that some of the results presented in 1090-WP28-04 apply to conditions more demanding than any of the RTCA requirements. Specifically, where the Nominal Update Interval is 3 sec., DO-242A specifies that the range requirement is 3 NM, whereas the first column in Table BB applies to 15 NM. That criterion is more demanding by 14 dB than any RTCA requirement. Another example is the 4th column in Table BB, which applies to 60 NM air-to-air range. The maximum RTCA requirement for air-to-air reception is 40 NM.

Based on the FAA's current growth-rate projection, which is 1.7 % per year, Lincoln has also evaluated performance out to 2035 using that growth rate. That was done for all of the columns in Table BB of WP28-04, including the two columns that go beyond RTCA requirements. The results show that air-to-air performance would satisfy all of the requirements through 2035 in all cases except for the 60 NM extended range case.

Summary

Intending to provide clarifications for the material in 1090-WP28-04, this paper gives additional material showing how the four environments A, B, C, and D relate to future dates and also relate to assumptions about growth rate in aircraft density for an area that is currently very dense. The assumed growth rate is quite large and is substantially higher than the current formal FAA projections. Performance results are also provided here and compared with the performance in the other paper. The differences are substantial, and the issues are currently under discussion among the organizations actively involved.

In generating DO-260A Appendix P, WG-3 found it useful to present evaluations by both Johns Hopkins APL and M.I.T. Lincoln Laboratory. To the extent that the results agree, that comparison helped to indicate confidence in the validity of the results. In working DO-260B, Appendix P, it would be useful to continue that practice. It seems likely that the differences in approach and techniques can be resolved, yielding results that support each other giving confidence to users of the document.