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Proposal for Redefinition of NIC=7 to Represent a New HPL Level

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Summary
This Working Paper addresses adding a new NIC Supplement for NIC=7.

Proposal for Redefinition of NIC=7 to Represent a New HPL Level

Problem Description / Issue

The current discretization of containment integrity levels into NIC codes is somewhat coarse compared to the level of detail needed for recent RAD ADS-B applications. Although the use of a NIC=6, for example is adequate to represent a containment level HPL<= 0.6 NM, sufficient for 3 NM TMA separation minima, the NIC level to represent 2.5 NM, 2.0 NM, 1.5 NM final approach applications, and independent parallel approaches are all specified as NIC=7 (HPL<= 0.2 NM), even though there is a significant difference in separation criteria between these applications. A finer level discretization of NIC=7 (TYPE code 12) is proposed, so that the final approach procedures with separation minima less than 3 NM can be distinguished from the general 3 NM TMA separation minima, and from the more stringent independent parallel approaches application which requires a true HPL <= 0.2 NM containment level. This finer discretization level may also be needed for future ADS-B applications.

From the viewpoint of current RAIM based GPS receivers, additional HPL levels are needed to assure a minimum HPL level with specified availability and continuity of function. For air-air separation applications, for example, availability of RAIM integrity needs to be at least 99.9% or higher for primary separation use (DO-242A ADS-B MASPS). Achieving this level of availability is dependent on the GPS satellite constellation as well as the type of GPS receiver used. The issue is that NIC=7 level containment integrity (HPL<=0.2 NM) can be problematic for both SA-Aware receivers and legacy SA-On GPS receivers. This is illustrated in Figure 1 below, where availability of HPL level in Seattle, WA is shown for two GPS satellite constellation assumptions, and for two GPS receiver types, assuming a typical 2 degree masking angle for both receiver types. (The bold lines represent availability versus HPL level for GPS week 410 (July, 2007) for SA-Aware and SA-Unaware receivers, respectively, and the thinner lines represent availability versus HPL level for the 'standard' SPS constellation assumptions with specified frequency of satellite outages from 24 active satellites (no outages) to 20 active satellites (4 outages).)

It is seen from the HPL sensitivity curves in Figure 1, that SA-Aware RAIM receivers are marginal in meeting the desired 0.999 availability level for NIC=7, assuming the standard SPS satellite constellation assumptions, but meet the desired availability level with some margin for HPL levels between 0.3 and 0.4 NM. Similarly, for Legacy SA-Unaware receivers, the desired availability level for HPL is not feasible with poor satellite constellations with 23 or fewer active satellites, but is easily met with HPL<= 0.3 NM for current satellite constellations with more than 28 active satellites in orbit. This suggests that an intermediate NIC level between 6 and 7 would be useful in assuring that a desired availability level is achieved for ADS-B separation applications, depending on GPS receiver type and current GPS satellite geometry. (In a minimum satellite environment, SA-Unaware receivers may not be capable of supporting separation applications at any NIC level>5, whereas SA-Aware receivers may be capable of supporting at least applications with minimum HPL<= 0.3 NM containment.)

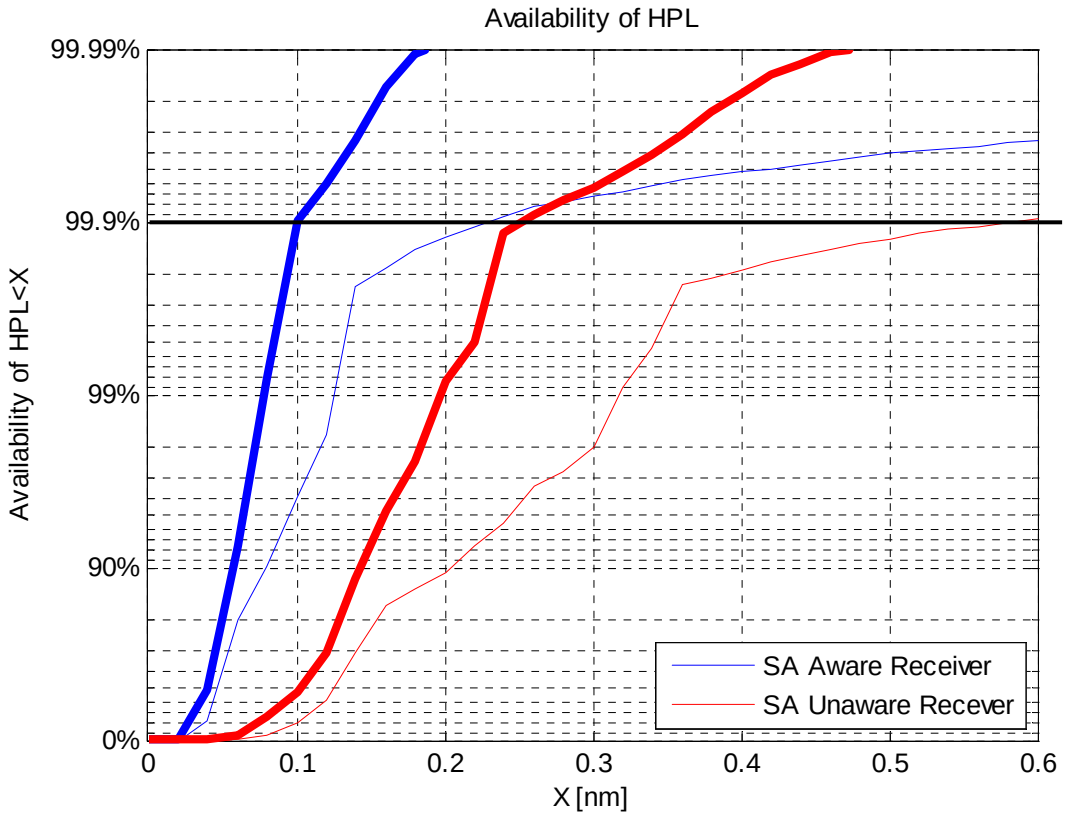

Figure 1: Availability of RAIM GPS Versus HPL Level Under Various Assumptions

Proposed Resolution to Issue

On the basis of the above discussion, the Boeing Company proposes that the NIC=7 level currently defined in DO-260A be redefined into two levels depending on the NIC supplement bit. The proposed redefinition for containment radius (R_C) is given by:

NIC=7, Supp bit =0 $R_C < 0.2$ NM (370.4 m)

NIC=7, Supp bit=1 $R_C < 0.3$ NM (555.6 m).

The specific value chosen is intended to support certain RAD TMA and final approach applications. The committee is invited to consider other possible HPL levels such as HPL = 0.35 NM, which supports somewhat higher availability and continuity of RAIM containment than HPL=0.3 NM, or to switch the bit 0 and bit 1 definition if that is more compatible with ordering consistency of NIC levels.