RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS

Meeting #5

A Comparison of Different Methods of Enhanced Reception

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SUMMARY

The purpose of this paper is to compare the reception performance of various enhanced reception techniques. This is an extension of data presented in section 4.7 of the Frankfurt report that compared the performance of the RMF Gold Standard Enhanced Reception technique with the LDPU and TCAS reception methods. In this paper, the same 6 minute sample from May 24, 2000 at Frankfurt FII – N40 air to air reception rate was examined using two additional enhanced reception techniques. One is the Center Sample enhanced reception technique like the method defined in the MOPS appendix I, and the other is a Multiple Amplitude Sample enhanced reception technique that does not use lookup tables which is not in the MOPS. These reception rates are compared to the RMF Gold Standard and the LDPU. A description of both the center sample and multiple sample techniques is contained in this paper.

Introduction

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Enhanced Reception Method Comparison

Like the RMF Gold Standard, the center sample and multiple sample reception methods are the result of non-real-time processing of the RMF data recorded in Frankfurt. The extended squitter counts were averaged over a 24-second wide time window to produce the aggregate average reception probability. Figure 1 shows the probability of reception for the four reception methods including the RMF gold standard, the RMF center sample method, the RMF multiple sample method, and the LDPU. In Figure 1, the center sample data series is highlighted in bold. The RMF center sample enhanced reception technique provides a reception performance similar to the LDPU.

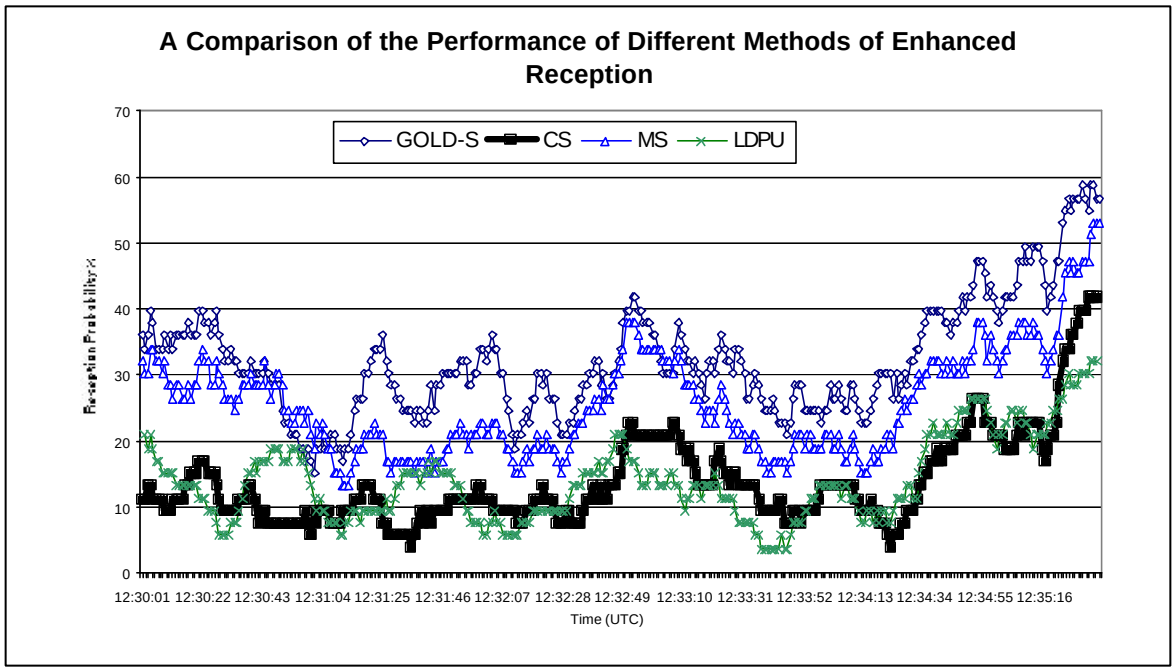

Figure 1 – The Four Enhanced Reception Techniques with the Center Sample Method Highlighted in Bold.

Figure 2 shows the probability of reception for the four reception methods with the multiple sample method highlighted in bold. The reception performance of the multiple sample method approaches the performance of the RMF Gold Standard.

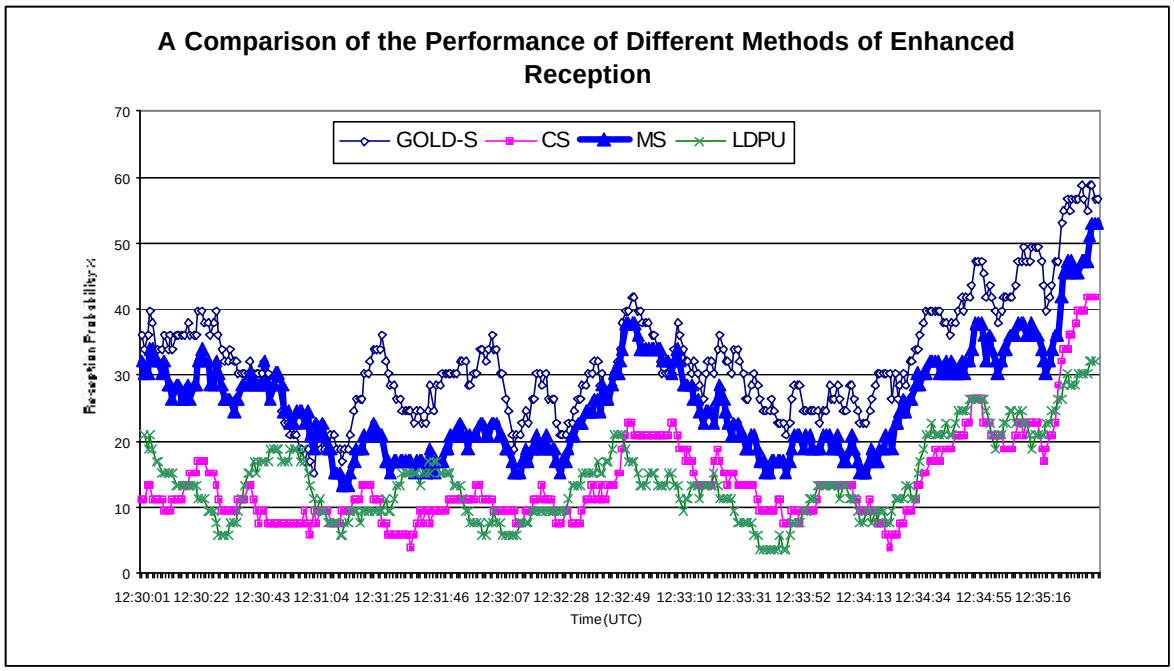

Figure 2 – The Four Enhanced Reception Techniques with the Multiple Sample Method Highlighted in Bold.

RMF Enhanced Reception Technique Description

The RMF Gold Standard reception technique is described in detail in Working Paper 1090-WP-3-08. The center sample and multiple sample methods that were used for this presentation are part of the same software module as the Gold Standard and differ only in the method used for bit and confidence declaration. All other detection processes such as preamble detection, preamble validation, reference level generation, etc, are performed in the same way. Error detection and correction for the three RMF reception methods are the same and include the use of the conservative technique followed by the brute force error correction. The bit and confidence declaration processes for the center sample and multiple sample methods are described below.

The Center Sample Method

A high confidence one is declared when the center sample of the one chip is within a + or – 3 dB band centered at the preamble reference level and the center sample of the zero chip is not. A high confidence zero is declared when the center sample of the zero chip is within a + or – 3 dB band centered at the preamble reference level and the center sample of the one chip is not. If neither of the above conditions is met, the bit is declared low confidence and the bit value is

awarded to the chip with the center sample that has the highest amplitude. If the amplitudes are the same the bit value is set to zero.

The Multiple Sample Method

The RMF samples at a 10 MHz rate, therefore each bit is seen by 10 samples and each chip is seen by 5 samples. The multiple sample method uses the amplitude of each sample and counts the number of samples in each chip that:

A. Is within the + or – 3 dB band centered at the preamble reference level
B. Is more than 6 dB below the preamble reference level

The use of all samples is an improvement over the center sample method because all samples are used in the bit and confidence decision process. Basically the ratio of samples categorized as either A or B above from each chip will determine the bit and confidence value. Ideally, in the absence of interference, each bit will contain all samples in one chip that are of category A and all samples in the other chip that are of category B. Neutral sample amplitudes that are neither A nor B (above the 3 dB band, or between the 3 dB band and the 6 dB threshold) will indirectly influence the decision process. The bit and confidence values are determined by the following decision process:

Confidence value defaults to LOW
Bit value defaults to 0

There are more A's in the ONE chip

Bit value = 1

Confidence value is set to HIGH if:

The number of A's in the ONE chip exceeds the number of A's in the ZERO chip by 3 or more

Or

The number of B's in the ZERO chip exceeds the number of B's in the ONE chip by 3 or more

Or

The number of A's in the ONE chip exceeds the number of A's in the ZERO chip by 2 or more AND The number of B's in the ZERO chip exceeds the number of B's in the ONE chip by 2 or more

There are more A's in the ZERO chip

Bit value = 0

Confidence value is set to HIGH if:

The number of A's in the ZERO chip exceeds the number of A's in the ONE chip by 3 or more

Or

The number of B's in the ONE chip exceeds the number of B's in the ZERO chip by 3 or more

Or

The number of A's in the ZERO chip exceeds the number of A's in the ONE chip by 2 or more AND The number of B's in the ONE chip exceeds the number of B's in the ZERO chip by 2 or more

The number of A's in each chip are equal but the Number of B's in the ZERO chip is greater

Bit value = 1

Confidence value is set to HIGH if:

The number of B's in the ZERO chip exceeds the number of B's in the ONE chip by 3 or more

There number of A's in each chip are equal but the Number of B's in the ONE chip is greater

Bit value = 0

Confidence value is set to HIGH if:

The number of B's in the ONE chip exceeds the number of B's in the ZERO chip by 3 or more