ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

Agenda Item 6: Aeronautical navigation issues

PROPOSED GNSS SERVICES IN THE DME BAND

(Presented by United Kingdom)

SUMMARY

In order to improve satellite related navigation services, the United States has decided to implement a second civil frequency on GPS, known as L5 in the band 1 164.45 to 1 188.45 MHz. In parallel with this initiative EC/ESA have also decided to offer to aviation a satellite system, called Galileo, which will also utilise the same band 1 164.45 to 1 188.45 MHz (E5a) and in addition 1 197.14 to 1 217.14 MHz (E5b). Aviation, through the work of the GNSS Panel has recognized many benefits that will accrue with the use of these frequencies in addition to those offered by both systems at E1-L1-E2 centred on 1 575.42 MHz.

However many ICAO States already operate the ICAO standardized distance measuring equipment (DME) which utilizes the band 960 to 1 215 MHz, leading to the potential of unacceptable interference between two systems where the bands overlap.

This paper recommends that the conference reviews the issues and prepares a work plan to find a resolution that would provide the optimum benefit for the the international aviation community.

Action by the conference is in paragraph 3.

(4 pages)

1. INTRODUCTION

1.1 Navigation by the use of satellites provides the international aviation community with solutions to the known restrictions caused by the use of terrestrial navigation aides. These solutions are well documented and led ICAO some years ago to support a communication, navigation and surveillance (CNS) concept which includes the use of satellites for navigation. The first satellite navigation system offered to the international aviation community was the United States global positioning system (GPS), followed by the Russian GLObal NAVigation Satellite System (GLONASS) system with European Galileo expected to start providing full services in the next few years.

1.2 Initially GPS offered a single frequency service to the international civil aviation community centred at 1 575.42 MHz although there was always an expectation of a much improved performance if a second frequency could be also be offered. Eventually the United States decided that it was in a position to provide this second frequency and chose to place it in the band 1 164.45 to 1 188.45 MHz.

1.3 In parallel with this initiative EC/ESA have also decided to offer to aviation a satellite system, called Galileo, which will also utilize the same band 1 164.45 to 1 188.45 MHz (E5a) and in addition 1 197.14 to 1 217.14 MHz (E5b).

1.4 However many ICAO States already operate the ICAO standardized distance measuring equipment (DME) which utilizes the band 960 to 1 215 MHz, leading to the potential of unacceptable interference between two systems where the bands overlap.

1.5 This paper discusses a work plan which will lead to action to resolve the issues to the benefit of the international civil aviation community.

2. TECHNICAL DETAILS

2.1 GNSS

2.1.1 GNSS works by satellites broadcasting their position and time to a user. If the user can acquire a minimum of four suitable satellites it is able to calculate its 3-dimensional position plus the correct time.

2.1.2 Errors that occur in the measurement of position and time can be caused by (among others), the:

a) troposphere;

b) ionosphere;

c) multipath; and

d) interference.

2.1.3 The use of two frequencies with wide-band characteristics mitigate against errors caused by (b) to (d) above. It was for this reason that the United States decided to modernize GPS with a second frequency for at L5 to compliment L1, and that the EC/ESA decided to design Galileo from the outset with three frequencies at E5a, E5b and L1.

2.1.4 The L5/E5 signals were also chosen to be placed in the Aeronautical Radio Navigation Band (becoming a joint Aeronautical Radio Navigation Band and Radio Navigation Band) as this gave the:

a) the best control against non-aviation interference sources;

b) allowed for real time ionospheric corrections (using two frequency method); and

c) provided the band width to reduce the impact of multipath on the positioning accuracy.

2.2 **DME**

2.2.1 The DME system operates in the band 960 to 1 215 MHz with each DME channel having a 1 MHz bandwidth and is described as follows.

2.2.2 The airborne unit (interrogator) interrogates a ground facility (transponder) that transmits a reply following a known calibrated fixed delay (known as the zero mile delay). The airborne unit then compares the slant range to the transponder by measuring the elapsed time to the receipt of the transponder reply. The measured range is then produced to the pilot and other aircraft systems as required.

2.2.3 Each interrogation consists of a pulse pair where the spacing of the pulses (or code) together with the RF frequency define the operating channel thereby allowing the interrogation to be addressed to a specific transponder. Similarly the transponder reply consists of a pulse pair having a code and RF frequency corresponding to the channel in use thereby allowing the airborne unit to distinguish desired transponders from other transponders within line of sight of the interrogator. For non-MLS paired DME channels there are two types of pulse spacing used:

a) X-channel: Transponder pulse pair spacing = 12 mseconds
X-channel: Interrogator pulse pair spacing = 12 mseconds

b) Y-channel: Transponder pulse pair spacing = 30 mseconds.
Y-channel: Interrogator pulse pair spacing = 36 mseconds

2.2.4 In addition to reply pulse pairs, the transponder radiates squitter and an identification signal. Both consist of pulse pairs that are identical to those transmitted in response to interrogations. Squitter consists of random transmissions of on-channel pulse pairs radiated at such a rate that when combined with reply pulses produces a total transmission of between 700 to 3600 (for TACAN) pulse pairs per second. These transmission rates are utilised by many interrogators to determine appropriate automatic gain control settings.

2.3 Potential for interference

2.3.1 From the brief technical descriptions given for the two systems (GNSS and DME) it can be noted that there is a potential for interference to occur between the two systems in the 1 197.14 to 1 217.14 MHz band and to a lesser extent (due to the frequency being used for special national allocations) in the 1 197.14 to 1 215 MHz band. The level and hence impact of interference is related to how many DME pulses transmitted in this GNSS portion of the band can be seen by the aircraft GNSS antenna. (Note in this portion of the band there are only ground transponder pulses, the airborne interrogators do not operate at these frequencies).

2.4 Mitigation of interference

2.4.1 Some ways of mitigating the interference while maintaining the aeronautical services is to reduce the number of DMEs pulses operating in the GNSS band. This could be achieved by:

a) replace/modify DMEs to reduce the quiescent squitter rate to as near to 700 pulse pairs per second as practicable (see ICAO Annex 10, paragraph 3.5.4.1.5.6);

b) by making greater use of Y-channel DMEs; and

c) by re-channelling the current frequencies where practicable.

in cases where it is found that the number of DME pulses in the GNSS band may introduce unacceptable levels of interference.

3. ACTION BY THE CONFERENCE

3.1 The conference is invited to:

a) consider the benefits of GNSS services in progressing the CNS/ATM concept by the provision of additional services in the 960 to 1 216 MHz band; and

b) agree the following recommendation:

Recommendation 6/ — GNSS services in the DME band

That,

a) States are encouraged to plan the deployment of DME's in order to minimize against any potential interference to satellite navigation services; and

b) an appropriate ICAO Panel be tasked to review the issues.

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