



INTERNATIONAL CIVIL AVIATION ORGANIZATION

**Regional Preparatory Group Meeting for World Radiocommunication
Conference 2003 (RPGM-2003)**

**And
AMCP WG-F Meeting**

(Nairobi, Kenya, 18-30 April 2002)

AGENDA ITEM 8: 1.5/1.6 GHz MSS bands issues

**PRELIMINARY STUDY OF SATELLITE SPECTRUM
REQUIREMENTS**

Executive Summary

(Presented by Christian Pelmoine)

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SATELLITE SPECTRUM
REQUIREMENTS**

Executive Summary

COM-SAT-REQ-D0

Edition	:	1.0
Edition Date	:	12 April 2002
Status	:	Released Issue
Class	:	EATMP

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title

PRELIMINARY STUDY OF SATELLITE SPECTRUM
REQUIREMENTS

EWP DELIVERABLE REFERENCE NUMBER –

PROGRAMME REFERENCE INDEX

COM-SAT-REQ-D0

EDITION :

1.0

EDITION DATE :

12 April 2002

Abstract

This report contains a preliminary estimation of the radio spectrum that would be required to support ATS services by 2012 in the ECAC States as a complementary system to the terrestrial Communication systems. This estimation aims at supporting the aviation position at the ITU WRC 2003.

Keywords

AMS(R)S

Data link

Spectrum

Satellite

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DOCUMENT STATUS AND TYPE

STATUS	CATEGORY	CLASSIFICATION
Working Draft <input type="checkbox"/>	Executive Task <input type="checkbox"/>	General Public <input type="checkbox"/>
Draft <input type="checkbox"/>	Specialist Task <input checked="" type="checkbox"/>	EATMP <input checked="" type="checkbox"/>
Proposed Issue <input type="checkbox"/>	Lower Layer Task <input type="checkbox"/>	Restricted <input type="checkbox"/>
Released Issue <input checked="" type="checkbox"/>		

ELECTRONIC BACKUP

INTERNAL REFERENCE NAME :

HOST SYSTEM	MEDIA	SOFTWARE(S)
Microsoft Windows	Type : Hard disk	
	Media Identification :	

DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.A	04/04/02	Original Draft	All
0.B	10/04/02	QinetiQ remarks	All
1.0	12/04/02	Final Eurocontrol comments	All

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FOREWORD

This document provides an introduction to two reports carried out for Eurocontrol which re-examine the preliminary requirements for satellite spectrum. Initial emphasis has been placed on meeting perceived European requirements but it is hoped that similar initiatives will be carried out in other regions of the world to re-consider the role of satellite communications to complement existing civil aviation communication technologies. The intention is that this subject can be re-opened by WRC 2003 through approving a dedicated agenda item for WRC 2006, so that aviation can secure dedicated spectrum to be allocated by WRC 2006.

1 BACKGROUND

The Aeronautical Mobile Communication Infrastructure [currently mainly based on systems operating inside the AM(R)S VHF band (118-137 MHz)] needs to evolve:

- 1) To accommodate increasing Aviation Traffic growth. This growth will no longer be supported without the introduction of additional communication capacity. The forecast growth is just under 4% a year and the current AM(R)S VHF band (118-137 MHz) is becoming saturated (despite numerous rationalisations and much re-planning currently going on in this band to optimise it).
- 2) To introduce enhanced Air Traffic service functions increasing flight safety, security and efficiency. These new functions will be supported by wireless data links able to support safety-critical functions. These data exchanges will increasingly complement voice communication, which, however, will still be required for immediate emergency and non-routine exchanges.

Alternative mobile communication systems are currently under consideration for introduction in the Mobile Communication Infrastructure, thus complementing the current systems.

One of the considered promising systems is satellite-based to be introduced as complement to the VHF systems in specific airspace (e.g. low density, upper airspace) and for specific services (e.g. ground-to-aircraft broadcast).

The 10 MHz spectrum band (i.e. 1545 - 1555 / 1646.5 - 1656.5 MHz), where such Satellite-based technologies should operate, is no longer exclusively assigned to aviation since WRC 97. However, the ITU, recognising safety-of-life specificity for aviation established foot-note S357.5A providing the aviation with a priority and instantaneous access. However, up to now, ITU has not identified inter-system pre-emption mechanisms satisfying the aviation safety-of-life requirements.

2 OBJECTIVES OF THE ANALYSIS

At previous World Radio Conferences (93, 97, 2000), ICAO, IATA and ESA produced estimates of the spectrum bandwidth which would be required to support aviation needs.

However, considering that new and more spectrum-efficient techniques are now available and that new operational scenarios are envisaged, it has been felt appropriate to re-consider the spectrum bandwidth calculation.

The aim of this re-assessment is to support the aviation position at WRC 2003 to request the introduction of an agenda item for the WRC 2006 aimed at securing an exclusive usage of a sub-part of the 10 MHz, thus allowing use of the rest of this band by other MSS without the need to implement complicated and unreliable priority and pre-emption mechanisms.

For WRC 2006 it is planned to have available a realistic and supportable detailed spectrum requirement calculation with particular emphasis on safety of life communications.

2.1 Review and Update of ESA SDLS study

The European Space Agency (ESA) established, for WRC 2000, an estimation of the spectrum required in the framework of the Satellite Data Link System (SDLS) with emphasis on meeting needs in the ECAC area in 2020. This report has been analysed and compared to a previous estimation done by the International Aviation Transport Association (IATA) in 1991 which estimated spectrum requirements in the years 2000, 2010 and 2020.

This review is contained in the deliverable "STUDY OF SATELLITE SPECTRUM REQUIREMENTS - Review and Update of ESA SDLS & IATA studies - COM-SAT-REQ-D1".

The analysis pointed out that for each of the studies, the scenarios, the application definition, and the traffic related figures would need to be verified. Although the basic methodology adopted in each study was sound, some of the assumptions need to be revisited.

The main points to be revisited for the ESA study were the rate of aircraft to be equipped, the specification of the ATS applications, the scenario for the voice communication, the AOC definition and traffic.

The IATA study needed an in-depth verification of the ATS applications, and to consider implementation of satellites service as a complementary mean (at least in the first steps).

Each of the studies needed also to be refreshed with a more up-to-date PIAC (Peak Instantaneous Aircraft Count).

2.2 Spectrum Requirement Recalculation

Having carried out a review of the studies, a recalculation of the spectrum requirements was undertaken based on more up-to-date information and assumptions. This update was done using the techniques outlined in the SDLS study which assumed an improved version of the current AMSS (e.g. P, R and T channels operating at 10,5 kbps and C channels operating at 5 kbps).

This recalculation is contained in the deliverable "STUDY OF SATELLITE SPECTRUM REQUIREMENTS - Overview of Civil Aviation Satellite Communications & Spectrum Requirement Refinement - COM-SAT-REQ-D2" (section 3.2.9)

With refined figures (1310 aircraft for the PIAC, revised ATS and AOC application requirements, a rate of 10 seconds for the APR specific service, the introduction of services in low density airspace and in complement to VHF for equipped aircraft, and voice in the upper airspace, the resulting spectrum was evaluated for 2012 to be approximately:

- 0.92 MHz for the forward link
- 1.46 MHz for the return link

This report provides, along with the role of satellite communications in aviation, a strategy for securing the necessary spectrum.

2.3 Technology dependent factors

The spectrum evaluation was then adjusted to take into account technical choices.

A CDMA access method (with granularity of 1 MHz) was assumed as it provides higher robustness to interference and higher resilience to localised failures while still providing spectrum efficiency similar to FDMA. As an effect of this choice, the bandwidth required for the return link was increased from 1.46 to 2 MHz. This additional bandwidth would leave room for capacity increase as well as a mitigation for the assumptions which were used during this assessment and which will be cleared during the next steps.

To provide the necessary availability required for the ATS applications, the design of the system uses satellite diversity. This design choice results in doubling the spectrum required.

2.4 End result

As resulting from the previous sections (refinement of the operational needs and effects of the technical choices), the spectrum requirement for the return link has been evaluated to 4 MHz (which is the most demanding link).

At the current stage and considering the need to mitigate the assumptions (which will be cleared during the next steps), it is proposed to assume a symmetric allocation (for forward and return link).

Therefore, as a preliminary evaluation of the spectrum required to cover the satellite-based Safety-of-life communication services over in the ECAC States by 2012 is:

- **4 MHz for the forward link**
- **4 MHz for the return link.**

3 NEXT STEPS

This proposed approach is a preliminary step aiming at the introduction of a relevant agenda item for AMS(R)S consideration at the WRC 2006. This approach will be completed by an in-depth analysis that will include, for the spectrum consideration, the following steps:

Identification of the European ATM context for Mobile Communication	Completed
Identification of the Mobile Communication Operating concept	Mid 2002
Identification of Satellite service requirements	End 2002
Identification of candidate satellite service potential solution(s)	End 2003
Presentation of the solution(s) to AMCP WG C	Early 2004
Identification of the accurate spectrum requirements, and Presentation to WG F	Mid 2004
Presentation to AMCP	2005 ?