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PRELIMINARY STUDY OF SATELLITE SPECTRUM REQUIREMENTS
Overview of Civil Aviation Satellite Communications & Spectrum Requirement Refinement

(Presented by Christian Pelmoine)

EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

PRELIMINARY STUDY OF SATELLITE SPECTRUM REQUIREMENTS
Overview of Civil Aviation Satellite Communications & Spectrum Requirement Refinement

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Abstract

This is the second of two related reports on the use of satellite systems to meet civil aviation communication requirements. This report briefly reviews the possible roles of satellite communications, possible technologies and concludes by proposing methods to ensure that adequate dedicated spectrum is available to meet aviation's needs in the future and a refined spectrum evaluation for 2012.

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TABLE OF CONTENTS

FOREWORD

This is the second of two related reports on the use of satellite systems to meet civil aviation communication requirements. This report briefly reviews the possible roles of satellite communications, possible technologies and concludes by proposing methods to ensure that adequate dedicated spectrum is available to meet aviation's needs in the future.

1 OBJECTIVES, SCOPE AND METHODOLOGY

1.1 Objectives

The purpose of this report is to recall the problems with the current aeronautical mobile communications infrastructure, and the role that satellite-based communications could play in overcoming these problems. The report also addresses how aviation could ensure that sufficient spectrum is available to meet its needs.

1.2 Overview of the Document

The document has three main sections as follows –

- Section 2 considers the role of satellite communications in civil aviation and its current status.
- Section 3 considers the potential of satellite communications systems in civil aviation. It also proposes ways to ensure that sufficient spectrum is available to meet future ATS communications in appropriate aeronautical radio bands.
- Section 4 provides an overall summary of to the report.

1.3 Methodology

In compiling this report a wide variety of sources were reviewed to identify the history and current status of the development of all aviation communication systems and how they relate to satellite communication.

2 CIVIL AVIATION COMMUNICATION REQUIREMENTS

2.1 Introduction

All forms of aviation need reliable communications, navigation and surveillance systems to enable them to operate safely and efficiently. The primary means of communications for civil aviation is VHF Radio Telephony (RT) and has been so for over 50 years. During that time the basic features have changed little except for the channel spacing which has gradually been reduced to provide more channels within the available spectrum. The latest reduction to 8.33kHz is probably the last reduction that can be made.

In parallel with the introduction of 8.33kHz channels, the increased use of VHF data links (e.g. Modes 2 and 3) operating in the same band could eventually decrease the amount of voice traffic but only to be replaced with data traffic. In the transition period it is likely that additional channels will be needed to support legacy installations until all aircraft have the appropriate avionics, further increasing the pressure on the VHF band.

Despite the increased number of channels available in the VHF AM(R)S band with 8.33kHz and the increased use of data communications, the growth in traffic is forecast to outstrip the available VHF spectrum by 2015. Therefore new communications systems with scalable growth capabilities (e.g. CDMA type systems) are being considered. Amongst the candidate technologies are satellite systems.

Satellite communications could play an important role in Europe and other parts of the world to provide communications in areas where it is difficult for terrestrial based systems to offer a service. Additionally satellite systems could provide an alternative communications medium to augment terrestrial systems or to act as a back-up system.

Satellite technology is already being used in support of ATS provision. One example of this is the use of satellite communications to support operational ATS in the Norwegian sector of the North Sea. In this area there are many helicopter flights at low level, many of which are beyond coverage of radar or VHF radio communications. Helicopter flights in these areas are required to fit ADS-C equipment and their position is monitored by ATC. This system (known as Modified ADS or MADS) uses the INMARSAT Aero-L system compatible with the ICAO AMSS SARPS to enable the transfer of positional information from the helicopters to the ATC centres. The FANS 1/A system also uses satellite communications to support ATS primarily in remote and oceanic parts of the world.

Despite the potential advantages of satellite communications, aviation has failed to utilise this medium at the projected levels and consequently spectrum that was dedicated for use by aviation within the Aeronautical Mobile Satellite (Route) System (AMS(R)S)[1] L-band has been effectively lost.

With increasing pressure on current aviation spectrum outside the AMS(R)S band (e.g. the VHF band), and with the possibility of new satellite systems being developed, a fresh approach to identifying the opportunities of satellite systems in civil aviation needs to be adopted. Whilst it may not be possible to produce a credible case for large exclusive allocations, by adopting a more realistic approach to the use of satellite technology it will be easier to produce a more acceptable case for a limited amount of dedicated spectrum in AMS(R)S band.

2.2 History and Current Status

In the early 1980s, INMARSAT, which was offering a satellite communications service to the maritime community, identified that this service could be extended to the aviation community. This was achieved through extension of the frequency range supported by the satellite transponder into the aviation band. This was seen as the lowest cost option to enable aviation to utilise satellite technology without the high cost of designing and launching its own system.

Around this time the ICAO Special Committee on Future Air Navigation Systems was established to plan how civil aviation could best use the emerging satellite technologies and other advances in CNS/ATM. Aviation was keen to utilise this new capability and foresaw that a global harmonised ATC infrastructure based on satellite systems had many attractions for airspace users and ATS providers. Aircraft operators saw the potential benefit of reducing the avionics systems needed to be carried on aircraft and ATS providers in developing countries could offer a service using satellites without the need to build up a costly ground infrastructure.

Mainly for financial reasons, the satellite communication system proposed, the Aeronautical Mobile Satellite Service (AMSS), relied on shared use within the aeronautical community for all user types ranging from safety and regularity of flight communications to passenger services (i.e. ATSC, AOC, AAC and APC). This was made possible through a pre-emption and priority process which was built into the ICAO

[1] AMS(R)S, is the term used by ICAO and ITU for satellite systems supporting two-way communications related to the safety and regularity of flight along national or international civil air routes.

Standards and Recommended Practices (SARPS) for the AMSS which all aviation users agreed to use. The AMSS supports safety and regularity of flight communications via three AMS(R)S priority levels. These are designated as Distress/Urgency (highest safety priority), Flight Safety, and Other Safety (lowest safety priority). ATSC is classified as Flight Safety and AOC is classified as Other Safety (lowest safety priority). At lower levels of priority are AAC and APC communications.

To ensure that aviation had the appropriate spectrum to meet its needs the aviation community united to provide the necessary evidence to justify the spectrum requirements. ICAO, its Member States and other international organisations produced a case for dedicated spectrum for the AMS(R)S band in the years 2000, 2010 and 2020 and this was accepted at the World Administrative Radio Conference (ITU-WARC) in 1992. This case relied heavily on a spectrum study carried out by IATA. The IATA study is reviewed in the companion report to this report entitled “STUDY OF SATELLITE SPECTRUM REQUIREMENTS - Review and Update of ESA SDLS study - COM-SAT-REQ-D1”.

However since that time the amount of exclusive spectrum dedicated to AMS(R)S has been progressively reduced to zero due to the so far limited utilisation of the spectrum compared to predictions and to the pressure from other users for more spectrum in the L-band.

In fact due to the costs associated with satellite communications and the need to have reliable data communications in remote and oceanic areas, aviation has developed an HF data link system adding further to the non take-up of satellite communications.

2.3 Opportunities for satellite technology

Satellites can provide communication in a wide variety of ways in today’s world ranging from fixed point to point services, VSATs and television broadcasts. Aviation has in the past been ‘opportunist’ in that when new satellite technology is proposed it seeks ways to exploit that technology. This will probably be the only way for aviation to get access to satellite communication as it cannot justify its own business case for a dedicated satellite constellation (e.g. recall the failure of the AEROSAT system in the 1970s). In doing this the ability of the emerging technology has to be carefully matched to the aviation requirements and this will depend on the application being supported e.g. ATSC, AOC, AAC or APC. When the prospect of using emerging MEO and LEO systems for aviation communications seemed feasible, considerable effort was expended in ICAO and other forums to standardise the requirements for these new systems so that they could support aeronautical communications. When the financial viability of the systems came into doubt (not due to aviation reasons) aviation had to accept this consequence and the possibility of using this technology disappeared.

Viable options for aviation to access satellite communications in the near to medium term is to utilise an existing satellite constellation using a dedicated sub-band of a mobile satellite service probably through a shared transponder. This sharing has to be governed by strict rules to ensure the high level of service required by aviation for safety of life communications.

Despite the failure of some satellite initiatives there are still a number of active satellite communications systems that are being used for, or could be considered for, aviation such as –

- The current AMSS up to 10 Kbps
- INMARSAT 64Kbps system
- INMARSAT 4 – up to 432 Kbps
- Direct Broadcast Satellite – Ku band transmit/receive systems (512Kbps/5Mbps)
- Satellite UMTS
- Satellite Data Link Service (SDLS) (ESA)
- LEO/MEO systems

Within the aviation community currently the only system for which validated ICAO SARPS exist is the AMSS, the history of which is discussed in section 2.2. The AMSS is characterised as a Geostationary Earth Orbit (GEO) system with 4 global beams with spot beams in dense traffic areas. The system operates in the L-band using 'bent pipe' transponders on the satellites i.e. the transponder transfers the feeder links frequencies to L-band which is used for communications with mobiles. In fact the aeronautical community shares satellite transponders with users of the Inmarsat Maritime Service which uses a different network. ICAO SARPs for this 1st generation of AMSS have been available from 1995.

The projected growth in the equipage of aircraft with AMSS has not been as great as projected. Satellite systems do have constraints compared with other forms of terrestrial aeronautical communication systems but the performance of the current AMSS is also limited which tends to unfavourably prejudice this form of technology. Perceptions of satellite communications include –

- Transit delay time of approximately 0.25 seconds in all communications (voice and data);
- Voice connection establishment different to current VHF RT;
- The need for centralised system monitoring;
- Lack of coverage at high latitudes;
- Satellite voice is seen primarily a replacement for HF voice communication;
- High cost of airborne installations and of the use of the link;
- Size of the avionics which for high rate systems excludes equipage on small and medium size aircraft;
- The need for institutional arrangements between the ATS providers and the communication service providers.
- The limited ATS applications of data link with sufficient cost-benefit to offset the costs.

In summary the general perception of current satellite communications systems is that they are expensive, only suitable for low-density airspace and are only likely to be fitted to long haul aircraft. This perception continues to favour the use of terrestrial based systems in high-density airspace to achieve the performance requirements.

In recent years new possibilities for the use of satellite technologies to support aviation communications are emerging which can overcome some of the limitations listed above. If geostationary satellites are used then there is little that can be done about the propagation delay but other limitations such as the cost and size of avionics may be able to be reduced due to new signal processing techniques.

Therefore due to the increasing pressure on the existing VHF spectrum and limitations of current technology, the time is right to re-evaluate the role that satellite communications could play in meeting aviation requirements.

3 THE ROLE OF SATELLITE COMMUNICATIONS IN AVIATION

3.1 Introduction

Satellite-based technology was a key feature of the ICAO CNS/ATM system which evolved from the ICAO FANS Committee work as endorsed by the 10th Air Navigation Conference. The benefits of satellite systems arise mainly due to their ability to provide services such as communications or navigation over a wide area depending on their orbit height. Geostationary satellites can illuminate around one-third of the earth's surface with global beams. Alternatively, to achieve greater performance in specific areas of the world, spot beams can be used.

In general it is unlikely that aviation can ever justify financially the ownership and operation of a dedicated space segment for aeronautical safety and regularity of flight communications i.e. ATSC and AOC communications. This philosophy was fundamental in establishing the existing AMSS by enabling all types of user access to the space segment with strict priority and pre-emption rules. It should be pointed out that this sharing is within the aviation community where it is possible to design and certify equipment to common rigorous standards to ensure correct operation.

It follows therefore that aviation has to share at least space segment resources e.g. transponders, ground infrastructure, etc with other users – in the L-band these will be other mobile users e.g. Maritime and Land. It may be possible to have dedicated aviation GESs provided this is economic and the design of the system allows small GES antennas.

The feasibility of sharing space segment with other users is obviously dependent on the technical and administrative arrangements in place to enable adequate levels of co-operation. In the design of the current AMSS intra-service sharing was considered possible within the aeronautical community as all avionics equipment was built and tested to a minimum operation performance standard and clear technical provisions were put in place to support priority and pre-emption rules. Inter-service sharing was considered but the technical and administrative arrangements were very complex and included incompatible processes for the development of equipment standards and approval. For example, the malfunction of satellite equipment e.g. 'permanent transmit' from a road freight vehicle could deny access to aircraft communications. Additionally sharing between services, if to be carried out efficiently, would also probably require dynamic or near-dynamic segmentation of the band.

The technical interface to achieve inter-service connection will be very difficult as the different transport modes have different networking systems and principles. The service providers could also be different.

The best approach for aviation to utilise satellite systems is to obtain a dedicated spectrum in a sub-band of MSS. This will also give confidence to the developers of these emerging systems. Therefore a reappraisal of the requirements for satellite spectrum has been carried out [Ref. 1] but this was aimed at the year 2020. As aviation will require additional communications means before this date, a case for securing dedicated spectrum in the intervening years is necessary, say, in ten years time.

3.2 STRATEGY TO SECURE AMS(R)S DEDICATED SPECTRUM

3.2.1 Introduction

Satellite technology could play a real role in aviation to meet the traffic growth throughout the world. To ensure that this is possible aviation must have access to appropriate spectrum. Based on previous submissions to the ITU, the credibility of the aviation community spectrum requirement cases could be in doubt in the ITU therefore future submissions must be better thought-out.

Keys to success include providing answers to the following issues but in a form that is understandable by non-aviation experts -

3.2.2 Identify an Operational Concept

The most important first step in defining bandwidth and spectrum requirements is to define operational requirements in an appropriate timeframe. In doing this there is an element of a ‘chicken and egg’ situation as some operational concepts may only be achievable with satellite systems. On the other hand the operational concept must be technology independent as far as possible and use satellite technology where it makes sense. For example, it is difficult to envisage that all communications will be carried by satellite in high-density airspace.

- **ATS Concept**

The timeframe must be sufficiently far in the future to allow technology to be available and implemented but not so far in the future that the scenario cannot be sufficiently detailed. A period of around 10 years from the present would be a reasonable compromise.

In addition the concept must indicate where communication service is required. For example, satellite systems provide communication between the aircraft and the ground. However in some ATM concepts when aircraft operate outside high-density airspace they operate autonomously using air-to-air communications (e.g. ADS-B). This requires little or not communications with the ground. Therefore any concept has to be consistent.

The role of voice and data must be considered. Is voice the primary means? How will it be used?

For ATS data link applications the concept should describe the services to be provided in which types of airspace, and quality of service. A formal way of capturing these requirements would be through, for example, the Operational Service and Environment Definition (OSED) as described in RTCA DO-264 or the equivalent EUROCAE document ED-78A. The development of a Required Communication Performance (RCP) model would add to the credibility.

- **AOC Concept**

For AOC the task is more difficult as the definition of what constitutes AOC traffic is open to interpretation. There is a grey area between AOC and AAC so there needs to be a clear division regarding the goals of AOC if the case for dedicated safety and regularity of flight communications spectrum (AMS(R)S) is to be made.

3.2.3 Applications

- **ATS**

It is important to identify a plausible set of applications for the type of operational scenario identified above. In Europe, the Eurocontrol COOPATS concept document describes the type of services. However there are likely to be different applications in different densities of airspace. For example in oceanic airspace the range of applications is likely to be smaller than in high-density airspace.

Although the use of data link in Europe is becoming mature, the density of traffic may not make communications via satellites the best choice due to the well-developed ground infrastructure. Other areas of the world where airspace densities are not so high such as Asia, South America, Australasia may provide better opportunities for the introduction of satellite technology (indeed this is already happening with FANS1/A equipage).

- **AOC**

There is a wide variety of information that could be considered as AOC including –

- Weight and Balance information
- ETA Estimation
- Out-Off-On-In Messages
- Flight Planning
- Maintenance data
- Information services (maps and charts)
- Performance data
- FOQA download
- Etc

It is likely, as is the case today, that airlines would require these applications to be available seamlessly wherever they operated. This could provide an increased opportunity for satellite communications.

3.2.4 Competing Technologies

Having identified the requirements and shown that new communications technologies are required these requirements have to be mapped to the appropriate technology. If they cannot be accommodated within the current allocations then new bands have to be found. However the requirements for spectrum for one technology cannot be treated separately from those of another technology. For example, a case cannot be made for X MHz for one type of technology and a similar amount of spectrum made for another technology meeting the same requirement. There has to be a coherent approach to defining spectrum needs across all the technologies.

Potential technologies, which can help to meet the aviation demand in the future, with probable timeframe, include -

Technology	Capability	Timeframe
VDL Mode 3	Will operate in existing VHF AM(S)R band so will not require any action in ITU.	2006 onwards
Terrestrial-based UMTS	Will require a new allocation or maybe able to use existing aviation allocations ?	2015 onwards
Satellite UMTS	Could be used to complement the terrestrial UMTS to offer a seamless worldwide service ?	2015 onwards

AMSS	Limited data rate but its use could be expanded given sufficient business case. However the costs and performance seem to prevent further growth	Available now
INMARSAT High Speed service	Not developed to meet safety and regularity of flight requirements but is likely to be used for some airline and passenger communications.	2003 onwards
SDLS	This system uses the same space segment as AMSS but includes new features specifically for safety and regularity of flight communications. It is claimed that the avionics is less expensive that that for the current AMSS.	From 2010 onwards
Boeing CNS	Proposed as the primary means of communication for future ATM infrastructure.	From 2010 ?

There may be other satellite-based technologies not listed that could support aviation requirements. Choice of spot or global systems will also have to be made as this affects the required spectrum.

3.2.5 Peak Instantaneous Aircraft Count

This is a fundamental element of any spectrum calculation. Studies in the past have tended to under-estimate the growth in air traffic. Reusing adjusted figures from previous studies is an acceptable method.

3.2.6 Equipage Rates

Having established the PIAC, the number of aircraft actually equipped with satellite communications equipment has to be estimated. Previous studies have tended to use a growth rate rather than aircraft type or assume total equipage. Today many long haul aircraft are equipped with satellite systems e.g. FANS 1/A. Apart from high-end General aviation aircraft, satellite systems are installed in few short- or medium-haul aircraft.

It is proposed that a population of aircraft types be identified for equipage with systems rather than assume a growth rate.

3.2.7 Stakeholder acceptance

An important part of the spectrum case to the ITU is that is backed by the aviation stakeholders through implementation plans or at least expectations. This requires all the aviation community to agree a worldwide position. This can only be done through organisations such as ICAO and IATA taking into account regional plans e.g. from Europe.

An important part of stakeholder acceptance is a strong business case.

3.2.8 Achieving acceptance in the ITU

The key to success in retaining spectrum has to be the credibility of the case, preferably backed by strong stakeholder support. The requirements have to be clear and based on clear objectives.

Previous experience has shown that projections 20 years into the future have been inaccurate therefore a shorter timeframe i.e. 10 years as proposed above would be more realistic.

Taking the issues raised above into account, and reusing an example case for spectrum requirements [Ref 1], a more realistic estimate can be developed as discussed in the next section.

3.2.9 Preliminary spectrum requirement for 2012

As a first step of the strategy as developed in section 3.2, this section provides the refined spectrum estimation for supporting the WRC 2003 request. This estimation, which is technology-independent, is based on the findings as identified in [Ref. 1]. From [Ref. 1] the revised PIAC for 2012 is about 3700 aircraft over the ECAC and immediate Oceanic area. In [Ref. 1] the distribution of aircraft in different airspace at the peak hour is –

Phase of Flight	Number of Aircraft (At peak hour in 2012)
Airport	316
Terminal Area	540
Continental High density	1535
Oceanic	947

High density	
Oceanic/ Continental Low density	363

By adopting the more realistic scenario that in this timeframe terrestrial systems will be used in high-density airspace and that satellite communications are more applicable to continental low-density and oceanic airspace, then the number of aircraft being supported by satellite communications is approximately 1310.

Using the method in [Ref. 1] for calculating the spectrum requirements for an FDMA system but based in the year 2012 instead of 2020 the following spectrum requirements can be determined. This assumes –

- Revised ATS and AOC application requirements as in Ref 1
- An APR rate of 10 seconds
- PIAC of 1310
- A dedicated continuous satellite ATS channel per upper airspace sector in the forward and return path for approximately half the sectors (approximately 100 sectors).

	Updated Spectrum	
	Forward link	Return link
ATS	0.71 MHz	1.13 MHz
AOC	0.21 MHz	0.33 MHz
Total	0.92 MHz	1.46 MHz

4 CONCLUSION

Satellite communications could play an important role in Europe and other parts of the world to provide communications in areas where it is difficult for terrestrial based systems to provide a service, and could also be used to complement terrestrial systems which are becoming overloaded e.g. VHF in high density areas. There are probably greater opportunities for satellite communications technology in areas of the world where the traffic is less dense and the ground infrastructure is less well developed.

New technology appears to have benefits over the existing AMSS, for example, SDLS, but this needs to be proved in practical trials.

To ensure that these emerging systems are able to be implemented the spectrum requirements must be matched against a realistic operational scenario and credible implementation plans to be defensible in ITU.

Aviation has produced estimates of satellite spectrum requirements in the past which have not so far been realised. This has partly been due to slippage in timescale due to economic reasons. Now aviation has to find ways to augment its communications capability and new satellite technology is emerging, it is a good time to reappraise the role of satellite communications for civil aviation and the resulting spectrum requirements.

Some initial work has been started in this paper and the related report [Ref. 1] but more work is needed not only from Europe but other regions of the world.

5 LIST OF TERMS AND ABBREVIATIONS

ACC	Area Control Centre
ADS	Automatic Dependent Surveillance
AEEC	Airlines Electronic Engineering Committee
AES	Aircraft Earth Station
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
ALOC	Airline Operations Centre
AMCP	Aeronautical Mobile Communication Panel
AMS	Aeronautical Mobile Service
AMS(R)S	Aeronautical Mobile (Route) Service
AOC	Airline Operational Control
AOR	Atlantic Ocean Region
APC	Aircraft Passenger Communications
ATC	Air Traffic control
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
ATSC	Air Traffic Service Communications
ATSU	Air Traffic Service Unit
bps	Bits per second
CDMA	Code Division Multiple Access
CFMU	Central Flow Management Unit
CPDLC	Controller-Pilot Data Link Communications
EATMP	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
ESA	European Space Agency
ETSI	European Telecommunication Standardisation Institute
EUROCAE	EURopean Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of the Air Navigation
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FIR	Flight Information Region
FL	Flight Level
FMG	Frequency Management Group
FMS	Flight Management System
GES	Ground Earth Station
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IOR	Indian Ocean Region
ISO	International Organisation for Standardisation

ITU	International Telecommunication Union
JAA	Joint Aviation Authorities
LSDU	Link Service Data Unit
MOPS	Minimum Operational Performance Standards
MSBN	Mobile Satellite Business Network (ESA)
MSS	Mobile Satellite Service
MTBF	Mean Time Between Failure
OSI	Open System Interconnection
PIAC	Peak Instantaneous Aircraft Count
POR	Pacific Ocean Region
SAR	Search And Rescue
SARPS	Standards and Recommended Practices (ICAO)
SATCOM	Satellite Communication
SDLS	Satellite Data Link System (ESA)
TDMA	Time Division Multiple Access
TMA	Terminal Manoeuvring Area
UIR	Upper Information Region
UTC	Universal Time Coordinated
VDL	VHF Data Link
VDR	VHF Digital Radio
WG	Working Group
ACC	Area Control Centre
ACG	ATM/CNS Consultancy Group
ACK	Acknowledgment Message
AEEC	Airlines Electronic Engineering Committee
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AMCP	Aeronautical Mobile Communication Panel
AMS	Aeronautical Mobile Service
ARINC	Aeronautical Radio, Inc.
ATC	Air Traffic control
ATS	Air Traffic Services
CFMU	Central Flow Management Unit
CHG	Modification Message
CIP	Convergence and Implementation Programme
Cont'd	Continued
DSB	Double Side Band
EANPG	European Air Navigation Planning Group
EATCHIP	European ATC Harmonisation & Implementation Programme
ECAC	European Civil Aviation Conference
EOBT	Estimated Off Blocks Time
ETSI	European Telecommunication Standardisation Institute
EUR RAN	European Regional Air Navigation (Meeting)
EUR Region	European Region
EUROCAE	EURopean Organisation for Civil Aviation Equipment

EUROCONTROL	European Organisation for the Safety of the Air Navigation
FIR	Flight Information Region
FL	Flight Level
FM	Frequency Management issues
FMG	Frequency Management Group
FPL	Flight Plan (Message)
FU	Follow-Up (issues)
GAT	General Air Traffic
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFPS	Integrated Initial Flight Plan Processing System
IFPZ	IFPS Zone
ITU	International Telecommunication Union
JAA	Joint Aviation Authorities
LoA	Letter of Agreement
MATSE	Meeting on the Air Traffic System in Europe
MOPS	Minimum Operational Performance Standards
MTBF	Mean Time Between Failure
NATS	National Air Traffic Services
REG	Regulatory (issues)
RET	Airborne & ground retrofit (issues)
RFL	Requested Flight Level
RPL	Repetitive Flight Plan
RRP	Re-Routing Proposal Message
RTCA	Requirements and Technical Concepts for Aeronautics
SAR	Search And Rescue
SARPS	Standards and Recommended Practices
TOR	Terms of Reference
UIR	Upper Information Region
UTC	Universal Time Coordinated
VDL	VHF Digital Link
VDR	VHF Digital Radio
WACS	Wireless Airport Communication Systems
WG	Working Group

6 REFERENCES

1. EUROCONTROL - STUDY OF SATELLITE SPECTRUM REQUIREMENTS Review and Update of ESA SDLS study

Other references –

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15-Oct-01	wgf7_wp16_8D_TEMP_149E.doc	AMCP WGF input to 8D	DRAFT REVISION OF QUESTION ITU-R 110/8
15-Oct-01	wgf7_wp12_8D_TEMP_137E.doc	AMCP WGF input to 8D	Work Plan for the DETERMINATION OF FEASIBILITY AND PRACTICABILITY OF PRIORITIZATION AND REAL-TIME PRE-EMPTIVE ACCESS BETWEEN DIFFERENT NETWORKS OF MSS IN THE BANDS 1 545-1 555 MHz AND 1 646.5-1 656.5 MHz
15-Oct-01	wgf7_wp11_8D_TEMP_136E.doc	AMCP WGF input to 8D	CONTRIBUTION TOWARDS IDENTIFICATION OF SCENARIOS WHERE REAL-TIME PRE-EMPTION WOULD BE REQUIRED
15-Oct-01	wgf7_wp10_8D_TEMP_134E.doc	AMCP WGF input to 8D	DRAFT REVISION OF RECOMMENDATION ITU-R M.1089
Oct-98	ESAcontributionWP8D.doc	ESA input to SG 8D	Long term spectrum requirements of AMS(R)S
May-98	Euroco~1.doc	ESA input to Eurocontrol SPG	CONSIDERATIONS ON THE AMS(R)S SPECTRUM ALLOCATION AT L-BAND (1.5/1.6 GHz)
Jul-98	Wgf_1.doc	AMCP WG A	WG-A Update of Satellite Spectrum Requirements - July 1998
Jul-98	Wp554.doc	AMCP WG A	FREQUENCY ALLOCATION FOR AMS(R)S IN THE 1.5 / 1.6 GHz BANDS