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A New Mechanism for management assignment and audit of the use of Aviation spectrum

(Presented by Christian Pelmoine)

**AERONAUTICAL MOBILE COMMUNICATIONS PANEL  
WORKING GROUP F  
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**Agenda item: 3**

**A NEW MECHANISM FOR MANAGEMENT ASSIGNMENT AND AUDIT OF THE  
USE OF AVIATION RADIO SPECTRUM**

**Presented by Ch Pelmoine, Eurocontrol, Brussels**

# A New Mechanism for Management, Assignment and Audit of the Use of Aviation Radio Spectrum

## 1 INTRODUCTION

In accordance with Directive No. 00/58 of 13 April 2000 of the Permanent Commission, the Agency was tasked to undertake the development and initiation of the plans and programmes stemming from the decisions taken by the ECAC Ministers at their 6<sup>th</sup> meeting, including those with respect to radio frequency spectrum, in partnership with the Administrations of ECAC Member States and their respective Air Navigation Service Providers.

This paper proposes the establishment of a new mechanism for management, assignment and audit of the use of aviation spectrum. An aviation spectrum strategy and a consequential Aeronautical European Common Position (AECP) are proposed as a means to achieve the objectives agreed by the MATSE/6 Meeting.

## 2 BACKGROUND

The availability of radio spectrum is vital for efficient air traffic management and its safety of life services<sup>1</sup>. Failure to be able to meet the demand for radio spectrum reduces the potential air traffic capacity thereby causing increased delays. Radio spectrum is of additional vital importance for military aviation users to ensure National Security and Defence responsibilities can be executed efficiently, effectively and safely.

During their MATSE/6 meeting, ECAC Ministers of Transport recognised that radio frequency spectrum is a scarce resource with finite capacity limits and for which demand is constantly increasing. Following the debate they adopted the position detailed below:

*“We note the importance to air traffic management in Europe of securing sufficient access to the radio frequency spectrum. In co-operation with ICAO, we shall seek to ensure that decisions made at the World Radio Conference later this year, and at subsequent Conferences, take account of the needs of the aviation community and set aside frequencies for Radio navigation systems and the future Global Navigation Satellite System (GNSS), for instance Galileo.*

*We have taken steps to improve the management of the existing Radio Frequency Spectrum in European airspace for the purpose of aviation, and in particular, have called on EUROCONTROL to address the need for a strong mechanism for the management, assignment and audit of the use of aviation spectrum within the airspace of ECAC States, in close co-operation with States and ICAO.”*

The ICAO EANPG also identified the need to rationalise the working arrangements for dealing with radio frequency matters.

An Ad-hoc group has been established to help the Agency in this work and this is actively supported by Austria, Belgium, France, Germany, The Netherlands, United Kingdom, ICAO, IATA, the Military and the European Commission.

In parallel to this ECAC process, The European Commission submitted to the European Parliament and the Council in July 2000 a proposal for a regulatory framework in radio spectrum policy in the European Community. This proposal is currently being discussed in the Council and Parliament; according to the present status of discussions, adoption is expected by the end of this year. The proposal is intended to ensure the harmonised availability and efficient use of radio spectrum where required to implement Community policies, in areas such as communications, transport, broadcasting and Research and Development.

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<sup>1</sup> ITU Radio Regulations S0.5 and S0.7 refer.

## DEFINITIONS

For the purposes of this document, the following definitions are understood:

- **Spectrum Management** is a strategic function dealing with all radio spectrum band allocations, ensuring adequate radio spectrum free from harmful interference for aviation.
- **Frequency Management** is a tactical function dealing with the planning of all frequency assignments within individual aviation bands.
- **Aeronautical European Common Position** is a civil and military aviation position on aeronautical spectrum bands in the ECAC area
- **Monitoring** is the on-going review of an activity with respect to agreed common specifications.
- **Audit** is the process whereby conformance to agreed methods is assessed at specified intervals.
- **Reporting** is the process detailing the outcome of an audit or monitor assessment that can then form the basis on which future corrective action can be taken if required.

## 3 CURRENT SITUATION

While the present spectrum and frequency management activities bring value, it is nevertheless recognised that the current processes need updating for greater efficiency.

For spectrum management, the activities being carried out within a number of organisations need to be better integrated into a coherent ICAO region wide activity. Furthermore, it needs a much higher profile both within and outside the aviation community.

For frequency management there exist certain planning criteria and co-ordination processes with associated databases. However, it lacks, among other things, the necessary automation tools to achieve higher levels of efficiency and quality.

### 3.1 Current Deficiencies

The main deficiencies of spectrum and frequency management are described in the following paragraphs.

#### 3.1.1 Resource Shortage

Effective spectrum and frequency management requires both adequate numbers of experts and funding. These are seriously lacking at both national and international levels. The current process is labour intensive and has the potential for error due to, among other things, multiple manual data input.

#### 3.1.2 Unfocused Direction of Effort

There are several interest groups in aviation, working on spectrum and frequency issues, that can reach different and, on occasions, contradictory conclusions. Decisions taken by individual States on matters of spectrum utilisation and planning affect others, often with an adverse impact at the European level.

#### 3.1.3 Reduced Influence on the CEPT and ITU

States that have undertaken to provide air navigation services, whether as a State run service or via a corporatised or privatised entity, have the ultimate responsibility for their "Safety of Life" services which depend on the availability of protected spectrum. Additionally, military aviation has responsibilities concerning National Security and Defence. However, the aviation community has little influence when spectrum allocation is determined. Only States may formally participate in the CEPT / ITU process. Historically the State representatives were closely associated with telecommunications organisations. These organisations are effectively in competition with aviation for spectrum and exercise significant political influence with governments. Consequently, there is the danger that aviation "safety of life" and national defence and security requirements will be compromised in favour of commercial gain.

### **3.1.4 Poor Use of Spectrum Efficient Technology**

Because of stringent safety requirements and the need for globally co-ordinated implementation, the introduction of new technology in the aviation industry needs a much longer lead-time than is the case in other industries. This in turn dictates that the technology used cannot be as up to date as that employed in high volume low cost consumer sectors.

### **3.1.5 Credibility Gap**

Civil and military aviation has some spectrum allocations that are under-utilised. An example is MLS, which became an ICAO Standard some 25 years ago but the implementation has been delayed because of changing strategies.

### **3.1.6 Ineffective Application of Processes**

The processes and procedures are not always applied uniformly by all States and other parties. This results in a lack of accurate data and lack of transparency in the current databases. In addition, they do not necessarily include all operational and planning considerations.

### **3.1.7 Lack of Quality Standards**

There is need for formally adopted quality standards to be applied to current practices and management systems.

### **3.1.8 Lack of a Spectrum Strategy**

Lack of a Spectrum Strategy makes it difficult to take into consideration, at an early stage, the impact of spectrum on aviation planning processes. Such a document would also provide useful input for the development of the ICAO position for the various World Radio Conferences (WRCs).

### **3.1.9 Lack of an Aeronautical European Common Position**

Lack of an endorsed Aeronautical European Common Position that includes both civil and military requirements impairs the ability of aviation to influence the highest political levels.

### **3.1.10 Lack of Implementation Planning**

A clear plan for implementation of the endorsed strategy for ATM/CNS is required.

## **3.2 Current Threats**

Some of the main threats to existing and future aviation spectrum needs are given in the following paragraphs.

### **3.2.1 Access to Additional Spectrum**

Spectrum is a finite and increasingly scarce resource and other industries are competing with aviation for spectrum. Additional allocations may be needed to satisfy existing and planned aviation requirements.

### **3.2.2 Protection of Existing Aviation Spectrum**

Due to the global nature of aviation spectrum allocations it is especially attractive to non-aviation radio services. When there are proposals which may impact aviation spectrum, the response is often not available in due time and aviation is not always able to participate in the relevant forums because of resource difficulties. For example, the Universal Mobile Telephone Service (UMTS) has been competing for spectrum in the aviation 10-cm band and has huge resources to support their case.

### **3.2.3 Loss of Expertise**

There is a danger that aviation could progressively lose expertise unless steps are taken to recruit and train.

### **3.2.4 Non-Radio Communication Systems**

Non-radio communication systems pose a threat. Historically they have been considered as non-radiating systems but practice has proven this not to be the case. For example, cable television can and does interfere with aviation VHF Communications and ATC Navigation Systems (VOR and ILS). Therefore the safety of life service is not protected from commercial interests.

### **3.2.5 Global Spectrum**

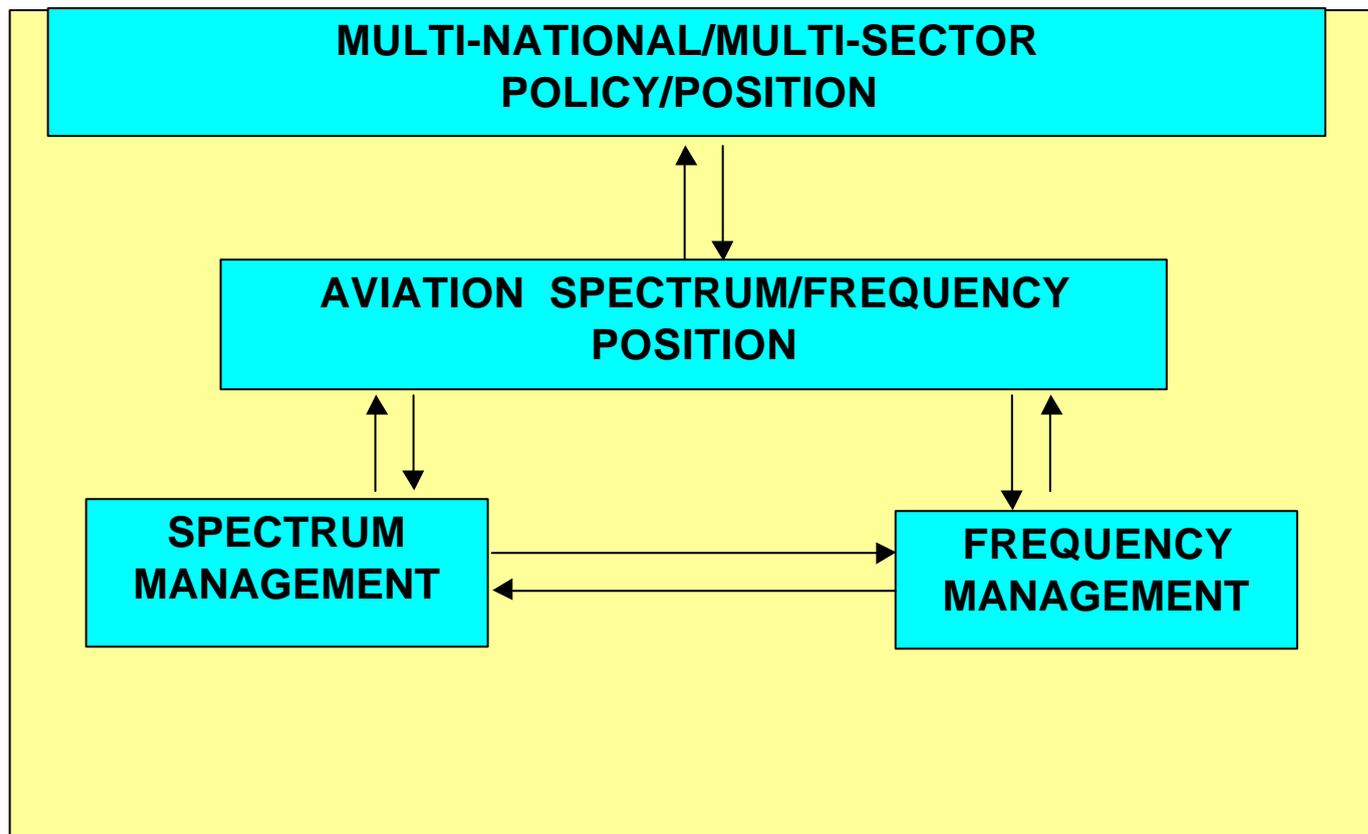
Aviation has to seek global allocations of spectrum, as it is a truly global industry. The fact that aviation spectrum has worldwide allocation means that it become very attractive to other competing industries.

### **3.2.6 Priority of Safety of Life Services**

It is a pre-requisite that, at a European policy level, the protection of safety of life services must have priority over commercial interests, which is not necessarily the current situation. For its part, the aviation industry must provide evidence to support the argument for the levels of protection.

## 4 HIGH LEVEL OVERVIEW

The interaction of spectrum and frequency aspects is illustrated in the diagram below.



### 4.1 Multi-National and Multi-Sector Aspects

4.1.1 The European Commission in its proposals for a Decision for regulatory framework for radio spectrum policy in the EC foresees the establishment of a consultative group, which should advise the Commission on the need to harmonise the use of the radio spectrum in relevant Community policy areas and assist in the formulation and application of a radio spectrum policy. The creation of a Radio Spectrum Committee is also foreseen.

### 4.2 Aviation Spectrum/Frequency Position

4.2.1 The aviation policy and position would be developed through a broad consultative process that would include, among others, the following key participants:

- Member States
- Air Traffic Service Providers
- Airspace Users
- Military authorities
- European Commission
- ICAO
- EUROCONTROL

4.2.2 The aviation position would be established through consultation with aviation related interests. Of key importance is the definition of an Aeronautical European Common Position that represents the

consolidated opinion of the aviation community. The final position would need to be approved by the Permanent Commission.

4.2.3 In view of the European Commission's proposals with respect to radio spectrum policy as well as with respect to the Single European Sky, interface will have to be established with the European Commission.

4.2.4 There is a close connection between aeronautical spectrum management and the frequency management activity although they are different facets of the same discipline. This enables the preparation of aeronautical positions based on quality data on current usage and future predictions that can be supported in the CEPT and ITU fora.

## 5 OBJECTIVES

5.1.1 The overall objective is to establish a new mechanism that not only accords with the objectives of the ECAC Ministers and ICAO but also addresses the security and defence needs regarding spectrum of the ECAC states. Introduction of the new system should start by mid-2002 in order that early benefits and improvements can be presented to the next MATSE meeting. Among other things, it is essential to establish co-ordination with ECAC and within ICAO/EUR region.

5.1.2 The spectrum management process described below will undertake to deliver:

- an Aeronautical European Common Position;
- Spectrum Strategy;
- technical analyses and studies;
- a continual assessment of threats to aeronautical spectrum;
- opportunities to justify additional spectrum for new services;
- centralised electronic access to all relevant information.

5.1.3 The frequency management process described below will undertake to deliver(1):

- an accurate description of current frequency usage;
- aeronautical frequency plans (short, medium, and long term);
- technical analyses and studies;
- frequency usage analyses for every frequency band (in short, mid and long term);
- a transparent database with appropriate security and confidentiality;
- an audit, monitoring and reporting system.

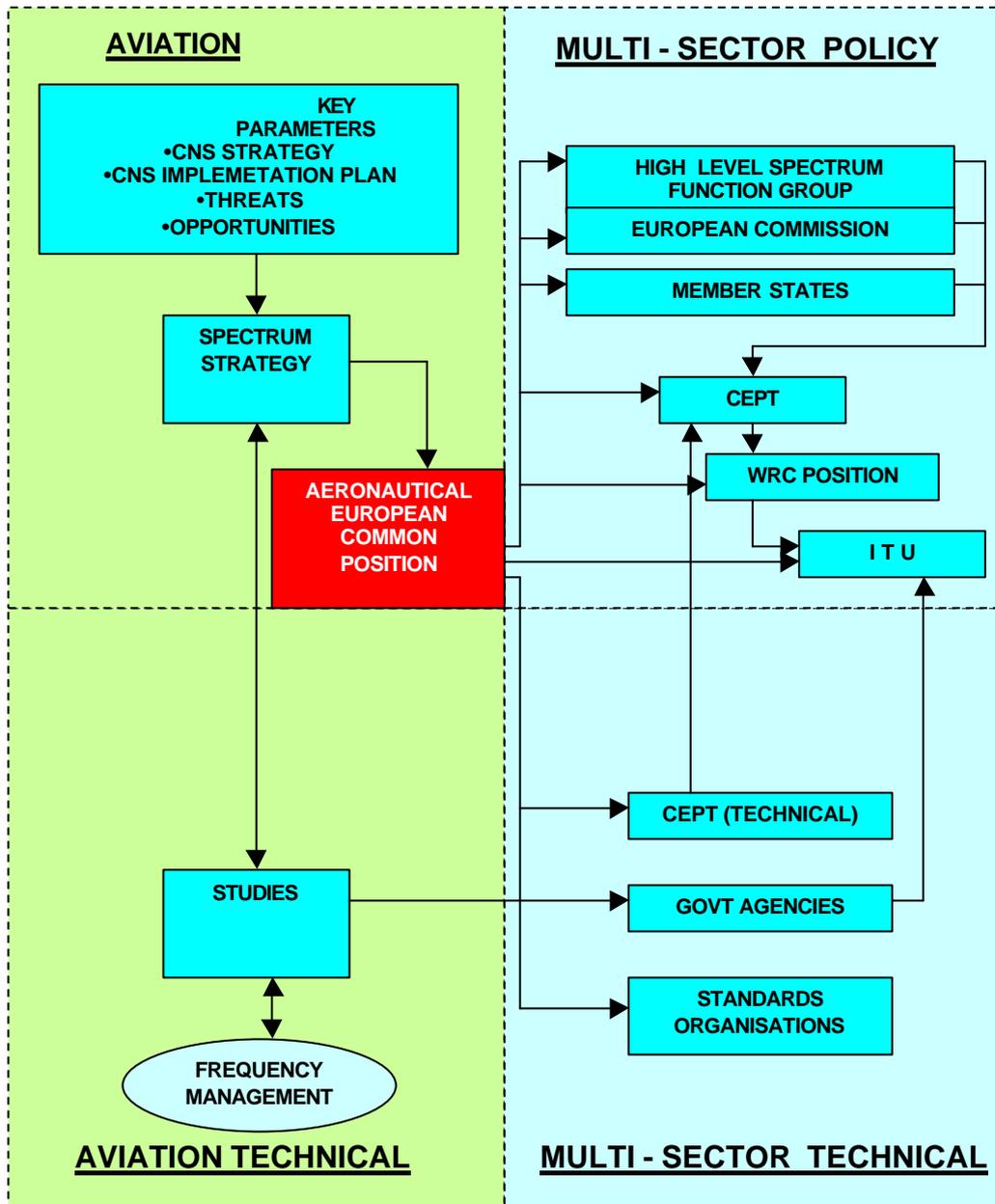
# SPECTRUM MANAGEMENT

## 6.1 The Spectrum Management Organisation

6.1.1 The functional elements of spectrum management are illustrated in the diagram below. This diagram is indicative, and as such, is much simplified. For example, not all linkages have been shown.

6.1.2 Essentially, the functions have been grouped into four categories, namely aviation position, multi-sector policy, aviation technical and multi-sector technical.

6.1.3 All functions must encompass both civil and military aviation considerations.



#### 6.1.4 Spectrum Strategy

An identified problem is the lack of an adequate spectrum strategy.

The Spectrum Strategy is a translation of future aviation requirements, including those described below, into a statement of spectrum requirements. It will consider quantity, quality and timing aspects. The Spectrum Strategy will take account of both civil and military requirements and would provide, when approved, the basis of the Aeronautical European Common Position.

The Spectrum Strategy would also enable, through feedback, ATM/CNS strategies and implementation plans to be amended as necessary.

The new process to create the Spectrum Strategy, which forms the basis for the draft Aeronautical European Common Position, is detailed in Section 9.

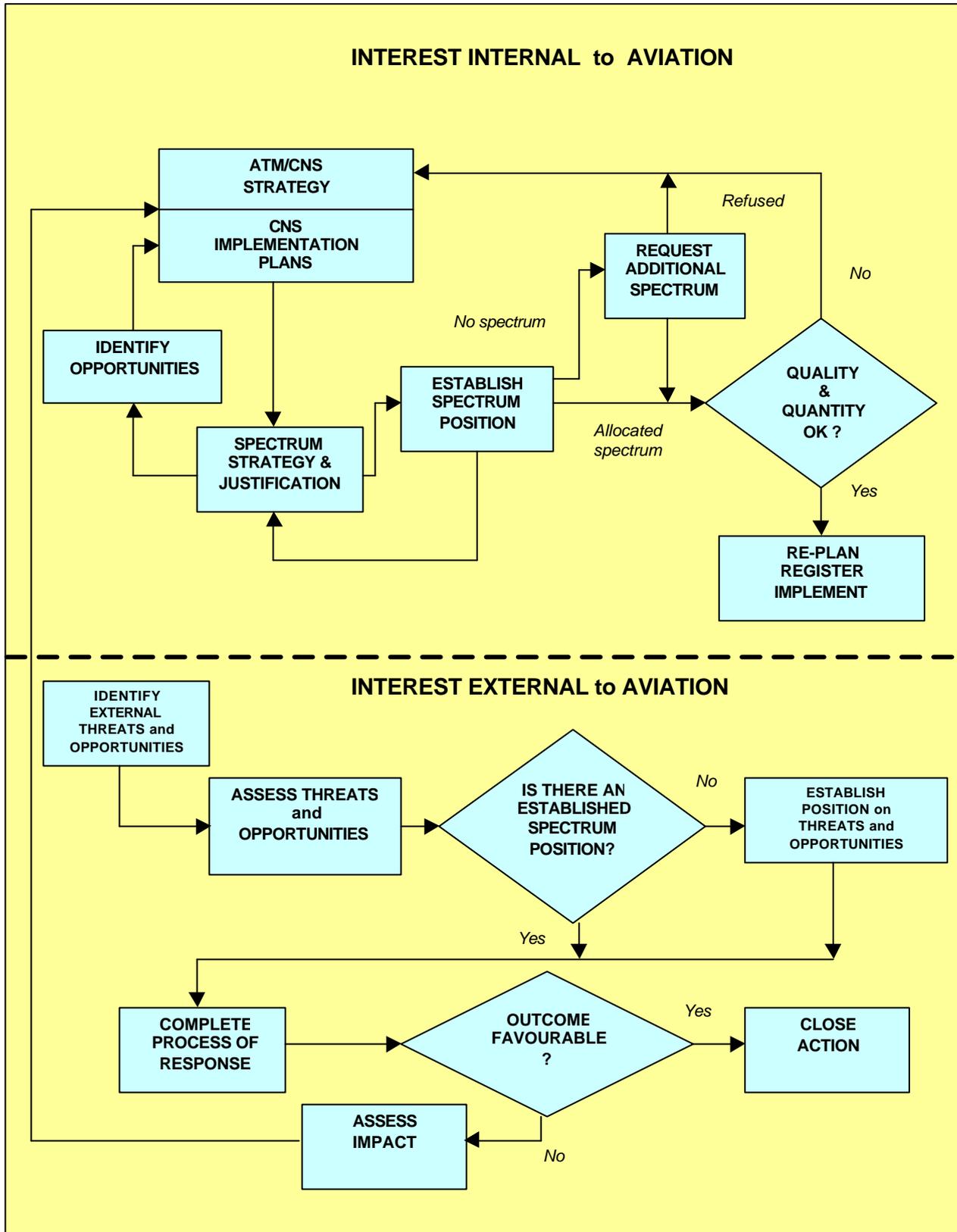
#### 6.1.5 Aeronautical European Common Position

The development of the draft Aeronautical European Common Position will require a similar approach as that taken for the Spectrum Strategy. In order for the Common Position to be binding on EUROCONTROL member States, it will need to be approved by the Permanent Commission.

The European Commission's proposal for a Decision on a Regulatory Framework for the Radio Spectrum Policy in the European Community will provide the framework where the main elements of the Aeronautical European Common Position will be debated in preparing the European Community multi-sector policy as shown in the diagram above. Among other things, Aeronautical European Common Position will be used to contribute to a WRC European common position.

## 6.2 The Spectrum Management Process

6.2.1 The streamlined spectrum management process is illustrated below.



### 6.3 Description of the Spectrum Management Process.

The following paragraphs describe the various elements in the previous diagram in Section 7.2.1.

#### 6.3.1 ATM/CNS Strategy / CNS Implementation Plans

The spectrum management process uses as its basic input the ATM/CNS strategy, CNS Implementation plans and stated military requirements, and, as and when necessary, seeks clarification on issues such as:

- 
- validation of the operational requirement,
- timescales,
- development of cost benefit analyses,
- establishment of prioritisation for existing and future CNS systems,

#### 6.3.2 Identify Opportunities

Investigate opportunities to use spectrum not previously allocated to aviation and ways to better use allocated spectrum to meet strategic objectives.

#### 6.3.3 Spectrum Strategy and Justification

Development of a spectrum strategy starting from the ATM/CNS and military spectrum requirements including justification based on: -

- the strategic and implementation plans .
- spectrum capacity.
- business case.

#### 6.3.4 Establish Spectrum Position

Development of spectrum position taking into account: -

- consistency with ITU and National Radio Regulations.
- establishment of prioritisation for spectrum usage.
- spectrum engineering - review of technological development.
- assessment of the timescales for realistic use of the future technologies.
- frequency planning.

#### 6.3.5 Request Additional Spectrum

Promote the aviation position to the radio regulation authorities, including request of additional radio spectrum. The aim is to ensure that the CEPT positions for the WRCs are balanced positions embracing the requirements of all spectrum users. To ensure the appropriate reflection of the Common Aviation Position participation and co-ordination of attendance by appropriate civil and military aviation representatives at key meetings is essential.

#### 6.3.6 Quality and Quantity OK

Evaluation of the quality of the service: -

- Study of the shared conditions and impact of interference from potential threats.
- When needed, determination of performance degradation, economic impact and safety case.

#### 6.3.7 Register re-plan Implement

Described in the frequency management process

### 6.3.8 Identify Threats/Opportunities

Monitor the Radio-regulations process (in national preparation, in CEPT, ETSI, ITU and in possible other processes) including,

- Participation and co-ordination of attendance at key meetings;
- Monitor the causes of interference;
- Investigate:
  - Safety aspects;
  - Legal aspects (radio regulation);
  - Technical aspects (spectrum engineering / frequency management);
  - Cost benefit analysis: economic risk and political influences;
- Identify aviation systems under threat;

### 6.3.9 Assess Threats and Opportunities

Investigate:

- The status of each aviation system under radio regulation and aviation;
- Technical aspects:
  - Define failure / degradation modes;
  - Spectrum engineering;
  - Frequency Planning;
- Operational/Safety aspects: impact of threat in terms of operational and safety concerns;
- Cost benefit analysis: impact of threat in economic terms;

Prioritize the systems under threat.

### 6.3.10 Is there an Established Spectrum Position

If an opportunity or threat is identified, action must be taken to determine if there is an existing spectrum position on the issue.

### 6.3.11 Establish Spectrum Position with respect to Threats/Opportunities.

With respect to the spectrum requirements including: -

- justification based on the spectrum position, strategic and implementation plans;
- establishment of the criticality of spectrum usage;
- threat assessments and cost impact;
- review of technological development.

### 6.3.12 Complete Process of Response

This is a key activity. It must necessarily include all possible actions, including political, to reach a satisfactory outcome for aviation.

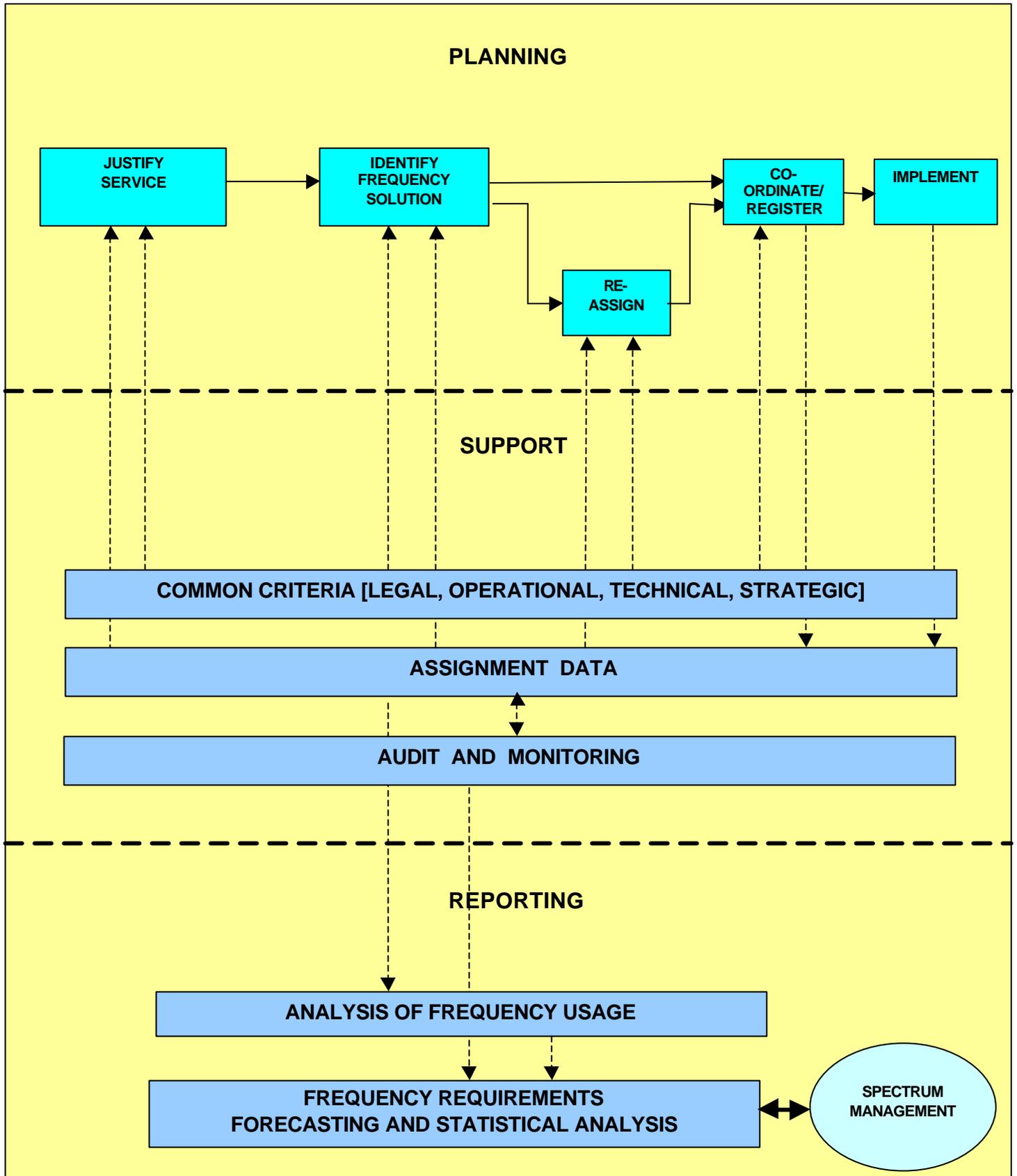
### 6.3.13 Outcome favourable

The actual result must be considered by stakeholders to determine whether or not the issue may be closed.

### 6.3.14 Assess Impact

Assess impact on the aviation position. Determine the performance degradation, economic impact and safety case for non-acceptance.

## 7 FREQUENCY MANAGEMENT PROCESS



7.1.2 The following frequency management process presupposes the establishment of a common database, with real time access and enhanced capabilities.

#### 7.1.3 Justify Service

To assess, based on agreed common criteria, whether a request for a new/modified frequency to enable a new/modified service is justified.

#### 7.1.4 Identify Frequency

To identify a suitable frequency assignment to satisfy the new/modified service.

#### 7.1.5 Re-assign

To identify alternative solutions when no frequency can be found by the standard planning process to satisfy the new/modified service. To ensure, based on agreed common criteria, that all efforts and co-operation occur to accommodate a new/modified service including re-assignment of frequencies.

#### 7.1.6 Co-ordinate / Register

The process to obtain formal agreement, from the States affected, for the assignment of the identified frequency and its consequent registration.

#### 7.1.7 Implement

The process that includes all steps (certification, building/system implementation, licensing, and etc..) up to the start of operations of the new/modified service and to report the implementation.

#### 7.1.8 Common Criteria

To provide a transparent set of agreed common criteria, available from a central repository that apply to the overall process. The development of these criteria will need to take into account the following issues:

- Legal
- Operational
- Technical
- Strategic
- Economic

#### 7.1.9 Assignment data

This function is concerned with making available, in a fully transparent and timely manner, the agreed data for every assignment. This will ensure up to date maintenance of this information.

#### 7.1.10 Audit and Monitoring

Auditing is expected to be conducted at various levels using common agreed processes.

To audit and/or monitor:

- the consistency of the assignment database with the operational and planned usage;
- that the parties are applying the agreed processes and common criteria;
- the processes and common criteria, and their applicability.

#### 7.1.11 Analysis of Frequency Usage

To review current frequency usage.

#### 7.1.12 Frequency Requirements Forecasting and Statistical Analysis

To analyse the capacity of the aviation spectrum when considering traffic increase scenario, special/important programs etc. To undertake simulations and analyses to provide detailed information on present and planned use of spectrum. It will be used to inform the management, the

spectrum protection domain and any other relevant parties should frequency congestion approach critical levels.

## 8 STAKEHOLDERS

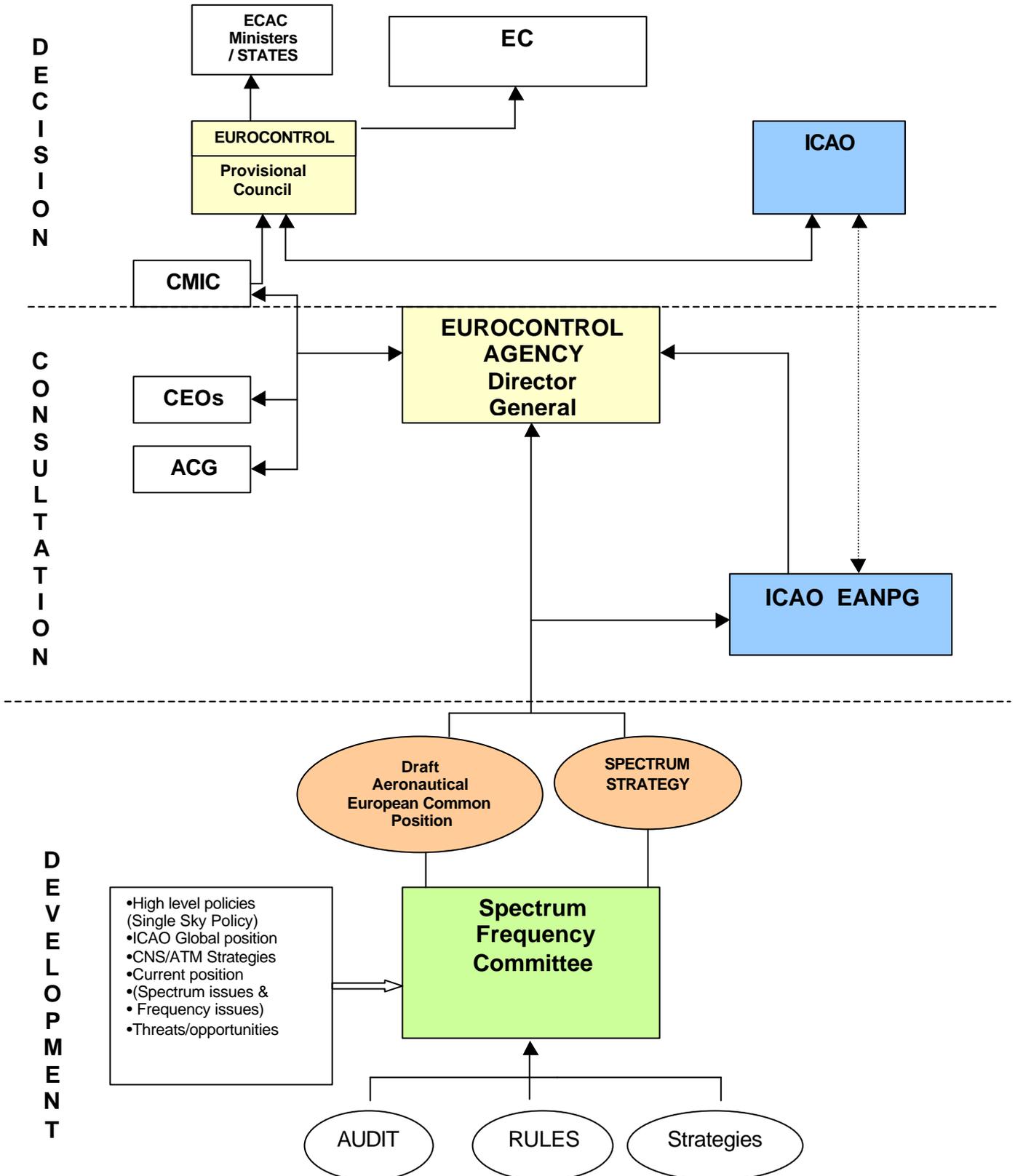
Key stakeholders include:

- ECAC Transport Ministers
- ICAO
- EUROCONTROL
- States and Air Navigation Services Providers
- The European Community
- Airlines and heir organisations
- JAA
- Military Aviation Community
- European Standardisation Institutes (e.g. EUROCAE, ETSI)

## 9 FUNCTIONAL STRUCTURE

The new process, to create and endorse the Spectrum Strategy and the draft Aeronautical European Common Position, is shown below. This diagram summarises the progress of the two main deliverables (Spectrum Strategy and draft Aeronautical European Common Position) from the development phase through to the decision phase. It does not reflect reporting lines.

### FUNCTIONAL STRUCTURE - AERONAUTICAL RADIO SPECTRUM POLICY



The Aeronautical European Common Position will need to be approved by the Permanent Commission . The current lack of visibility on the European Spectrum Strategy is deemed a major weakness.

## **9.1 Development Phase**

### **9.1.1 Spectrum Frequency Committee**

Responsibility for the development of the Spectrum Strategy and draft Aeronautical European Common Position would be given to the Spectrum Frequency Committee (SFC). It would be composed of representatives from all stakeholders. It would consider current policy and strategic issues related to spectrum and frequency management.

Initial material for the work would be based upon a number of input sources such as:

- National and international policies
- ICAO Global Position
- ATM/CNS Strategies
- Current situation regarding spectrum and frequency issues
- Perceived threats and opportunities
- Military requirements and current NATO frequency management policy

Moreover, the SFC would be well positioned to undertake high level audits of spectrum and frequency utilisation.

### **9.1.2 Technical Function**

It is envisaged that the detailed technical support for frequency and spectrum management will be provided by a new group to be established under the aegis of the ICAO EANPG.

### **9.1.3 Support Function**

The support necessary for the development of the Spectrum Strategy and the draft Aeronautical European Common Position will be provided by the Agency.

## **9.2 Consultation Phase**

The two deliverables from the SFC would be considered by the ICAO EANPG, to ensure a wide consultation within the ICAO European Region, and by CMIC.

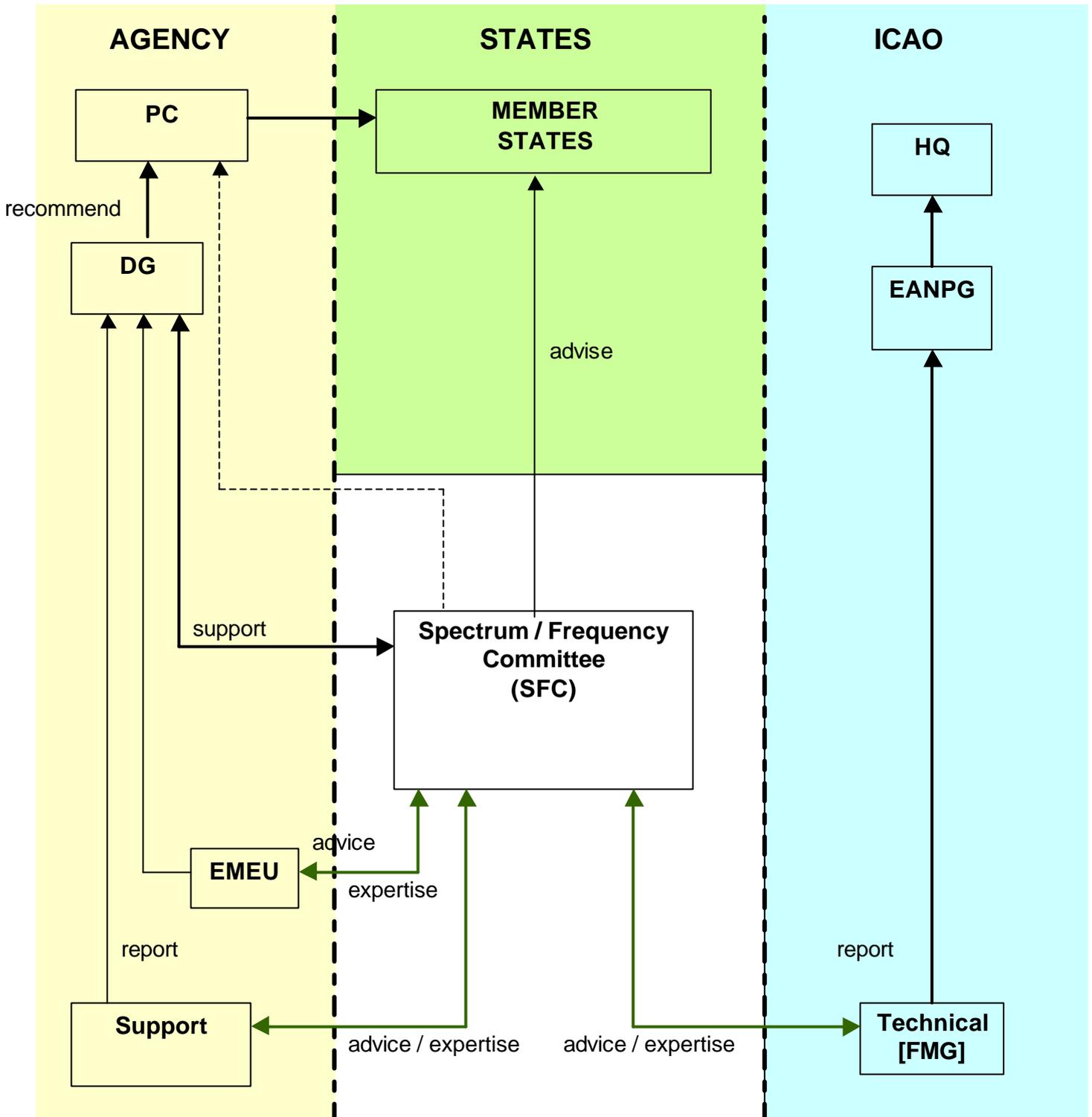
## **9.3 Decision Making Phase**

The Spectrum Strategy and draft Aeronautical European Common Position will be submitted to the approval of the Permanent Commission.

## 10 ORGANISATION STRUCTURE

The reporting structure to support the new mechanism is illustrated below. This compliments the Functional Structure described in the previous Section.

### REPORTING STRUCTURE - AERONAUTICAL RADIO SPECTRUM POLICY



## 10.1 Rationalisation

Existing groups, namely the FMG, ARB and SPG , can be dissolved and the resultant scarce resources used to support the new mechanism, in particular the Spectrum Frequency Committee and the Technical Function.

Existing budgetary allocations can be used to support the new mechanism but the benefits will be constrained.

## 10.2 EUROCONTROL's Agency

A Spectrum Frequency Committee will be established, comprising all relevant stakeholders. The necessary resources will be provided from the Agency budget to maintain the efficient operation of the Spectrum Frequency Committee; Agency support to the Spectrum Frequency Committee will be provided by existing Agency resources, and will include appropriate civil/military advice and expertise. The Spectrum Frequency Committee will report to the Director General.

## 10.3 ICAO

The ICAO EANPG would act in a consultative role and report to the ICAO Headquarters in Montreal. The ICAO would continue to provide the appropriate support for the EANPG.

## CIVIL - MILITARY CO-OPERATION

**11.1** Both civil and military radio spectrum is being challenged by commercial organisations. For example, the desire of the mobile telephone industry to use certain radar frequency bands. Consequently, there is an essential need for civil and military aviation authorities to be engaged in the development of a draft Aeronautical European Common Position.

**11.2** Civil communications systems are not as advanced as military counterparts, but work has started to determine the possibility of using spread-spectrum technology because it could provide a flexible use of spectrum.

**11.3** There would be mutual benefits if civil - military co-operation on this subject could be established with one objective being the identification of lesser-used frequency bands that might be used by both parties.

**11.4** More work must be done to identify the precise detail of how military authorities and existing alliance Frequency Management authorities will be engaged in the development of the Strategy, the Aeronautical European Common Position and consequent Spectrum & Frequency management processes.

## 12 RESOURCES

**12.1** There are currently 2 Agency staff dedicated to spectrum and frequency aspects. Two contractors and a seconded staff member assist them. Investment expenditure is foreseen for the following work:

- studies and analyses to support aeronautical spectrum requirements<sup>2</sup>;
- implementation and maintenance of the new processes;
- support for Member States and ICAO regarding frequency management systems.

**12.2** These costs for the basic work, that are already part of the FY 2002 budget and 2003-2007 Five-Year Plan<sup>3</sup>, are summarised below:

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<sup>2</sup> Much of this work is contracted to Member States and Air Navigation Service Providers.

<sup>3</sup> Inflation rates applied are 5% for internal effort and 3% for external effort.

<b>Budget</b>	<b>2002</b>	
<b>Item</b>	FTE	kEur
Internal Effort	2	290
External Effort	2.5	300
Investment		300
<b>Total</b>	<b>4.5</b>	<b>890</b>

<b>Budget</b>	<b>2003</b>		<b>2004</b>		<b>2005</b>		<b>2006</b>		<b>2007</b>	
<b>Item</b>	FTE	kEur								
Internal Effort	2	315	2	330	2	347	2	364	2	382
External Effort	2.5	309	2.5	318	2.5	328	2.5	338	2.5	348
Investment		600		610		630		600		600
<b>Total</b>	<b>4.5</b>	<b>1224</b>	<b>4.5</b>	<b>1258</b>	<b>4.5</b>	<b>1305</b>	<b>4.5</b>	<b>1302</b>	<b>4.5</b>	<b>1330</b>

**12.3** The efficiency gained through implementation of the new processes will enable Member States to review the balance between their own scarce expert resources and those provided by the Agency. It is anticipated that substantial savings could be made. Such a review should be undertaken once the processes are operational. Activity already undertaken on spectrum and frequency issues has been in support of the Agreement of Co-operation of 27/03/1996 between EUROCONTROL and ICAO.

## 13 CONCLUSIONS

- Spectrum and frequency management is of high importance to both military and civil aviation.
- The establishment of the processes and structure described in this document will enable the deficiencies identified at the beginning of the document to be remedied, particularly with regard to aviation's influence in the CEPT/ITU processes.
- There is an urgent need to develop and maintain a Spectrum Strategy and Aeronautical European Common Position that must include military requirements.
- There is an opportunity to improve the current processes and procedures that will lead to more efficient management of the radio spectrum resource.
- There is an urgent need for the development and early implementation of database software tools to support the processes.
- There is a requirement to improve accuracy, quality and transparency of data and processes.