CONSULTA PÚBLICA SOBRE O QUADRO NACIONAL DE ATRIBUIÇÃO DE FREQUÊNCIAS 2007 – RESPOSTA DA ONAIR

A OnAir vem responder ao procedimento geral de consulta do ICP-ANACOM sobre o Quadro Nacional de Atribuição de Frequências 2007 (QNAF).

I. SOBRE A ONAIR

A OnAir é uma empresa comum constituída pela SITA e pela Airbus em Fevereiro de 2005. A OnAir tem sede em Genebra, na Suíça (www.onair.aero).

A SITA é o principal prestador de serviços de comunicações e soluções informáticas a nível mundial da indústria de transporte aéreo (www.sita.aero). Os seus mais de 600 membros são empresas activas no sector do transporte aéreo e têm actualmente cerca de 1800 clientes, entre companhias aéreas, aeroportos, empresas de *design* aeronáutico, empresas logísticas, organizações internacionais e governos.

A Airbus concebe, vende, constrói e presta suporte à família de aeronaves mais completa to mundo (www.airbus.com).

II. O SISTEMA ONAIR

A OnAir pretende disponibilizar aos passageiros de transporte aéreo serviços de comunicações compatíveis com o seu equipamento actual (computadores portáteis, telefones móveis e PDAs) assim como serviços distintos que utilizará equipamento terminal integrado nas próprias aeronaves.

Para a prestação do serviço são utilizadas bandas de frequências GSM 1800 (1710-1785 MHz e 1805-1880 MHz) a bordo da aeronave. Estas bandas GSM foram seleccionadas porque a potência mínima de transmissão de um equipamento móvel é menor nesta banda do que na banda GSM 900. Adicionalmente, o amortecimento do sinal (“damping”) nas bandas GSM 1800 é superior.

Uma rede (constituída por uma única estação de base) com baixa potência ("picocell") GSM 1800 será instalada na aeronave. Desta forma, um equipamento terminal móvel GSM (ou outro equipamento terminal que utilize o sistema GSM) de um passageiro ligado conseguirá ligar-se a esta rede.

Este tipo de rede de baixa potência foi concebido para não perturbar o equipamento da aeronave. Adicionalmente, uma unidade de controlo de rede impede que o equipamento terminal móvel GSM tente procurar uma ligação com redes terrestres.

Neste sentido, o equipamento do passageiro conseguirá ligar-se à rede da OnAir enquanto a aeronave está em movimento.

A rede da aeronave comunica com as redes de comunicações terrestres (a rede do passageiro e outras redes) através de um satélite. Inicialmente, será utilizada pela OnAir a rede Inmarsat para comunicar com as redes terrestres. A estação de base terrestre da OnAir assegurará o encaminhamento das chamadas através da interligação com operadores de comunicações terrestres.

Esta configuração presume a existência de acordos de *roaming* entre os operadores de serviços de comunicações dos passageiros e a OnAir.

Este sistema apenas será utilizado a uma altitude superior a 3000 metros e será desligado durante a descolagem e aterragem da aeronave.

Inicialmente, o sistema OnAir irá oferecer serviços de voz. A breve trecho está prevista a possibilidade de utilização do serviço de acesso à Internet.

III. ENQUADRAMENTO REGULATÓRIO

A OnAir defende que deverá ser aplicável a este sistema o princípio do país de origem.

Neste sentido, deverá ser obtido um direito de utilização de frequências no país de registo da aeronave para operação da rede (instalada na aeronave) e prestação de serviços de comunicações electrónicas.

Os restantes países – sobre os quais a aeronave sobrevoará e cujo espectro radioeléctrico será utilizado pelo sistema – deverão garantir o mútuo reconhecimento do direito de utilização do espectro radioeléctrico concedido pelo país de origem.

Sublinhe-se que o facto de o sistema apenas funcionar a uma altitude superior a 3000 metros garante que não existe qualquer possibilidade de interferência ou sobreposição com as redes de comunicações móveis GSM 1800 presentes nos respectivos países sobre os quais a aeronave sobrevoa.

Este aspecto é muito importante para o correcto enquadramento regulatório do sistema OnAir.

Este enquadramento regulatório e o princípio do mútuo reconhecimento das autorizações foi recentemente sufragado pela CEPT na sua Decisão ECC/DEC/(06)07, de 1 de Dezembro de 2006, relativa à utilização harmonizada de sistemas GSM aéreos nas bandas de frequências 1710-1785 MHz e 1805-1880 MHz.

Junto se envia, como Anexo I, um breve relatório preparado pela OnAir sobre o enquadramento regulatório do sistema OnAir em diversos países e as iniciativas actualmente em curso com vista ao início da prestação de serviços.

Junto se envia ainda, como Anexo II, uma cópia da Decisão ECC/DEC/(06)07.

IV. QNAF

O QNAF actualmente em vigor (2005-2006) identifica 150 canais nas frequências nas bandas 1710-1785 MHz e 1805-1880 MHz que estão reservadas para utilização pelos operadores de serviços já licenciados pelo ICP-ANACOM para o serviço móvel terrestre acessível ao público em caso de comprovada necessidade.

Este facto, aliado ao facto que os canais atribuídos aos operadores de comunicações móveis terrestres serem de utilização exclusiva, significa que actualmente não existe espectro disponível nas bandas 1710-1785 MHz e 1805-1880 MHz.

O QNAF em consulta, ao invés, determina que estes canais estão reservados sem definir a utilização respectiva. Determina ainda que estes canais poderão ser atribuídos na sequência da manifestação de interesse promovida pela consulta pública.

A OnAir congratula-se pelo facto de o ICP-ANACOM admitir permitir que outros operadores possam utilizar o espectro radioeléctrico nestas bandas de frequências.

Ora, o serviço OnAir, como já foi referido na secção II deste documento, implica a utilização do espectro radioeléctrico precisamente nas bandas 1710-1785 MHz e 1805-1880 MHz.

No entanto, e como foi explicado, esta utilização não afecta de forma alguma a utilização realizada pelos operadores actuais de serviço móvel terrestre (TMN, Vodafone e Optimus), já que o sistema OnAir só funciona a altitudes superiores a 3000 metros. Neste sentido, não há qualquer risco de interferência entre a rede da OnAir e as redes dos operadores de serviço móvel terrestre.

Ou seja, a OnAir e os operadores de serviço móvel terrestre podem utilizar os mesmos canais.

No entanto, e de acordo com o QNAF em consulta (o mesmo é verdade no QNAF em vigor), os canais atribuídos aos operadores de serviço móvel terrestre são canais de utilização exclusiva.

Ora, esta limitação não parece ser justificável perante a descrição dos serviços aqui realizada.

De facto, e tendo em vista que (i) não existe qualquer hipótese de interferência, e (ii) as redes dos operadores em questão são redes terrestres, não parece justificável a manutenção de direitos exclusivos acima dos 3000 metros de altitude.

Não vemos qualquer justificação de teor técnico ou regulatório para o QNAF não determinar que estes canais poderão ser de utilização partilhada em determinadas situações.

Esta alteração promoveria uma utilização mais eficiente no espectro radioeléctrico.

Adicionalmente e como decorre do exposto, permitiria ainda a prestação de serviços inovadores como por exemplo o sistema OnAir.

V. CONCLUSÕES

A OnAir entende que o QNAF deverá:

1. Explicitar que os canais nas bandas 1710-1785 MHz e 1805-1880 MHz para o serviço GSM são de utilização partilhada quando utilizados em altitudes superiores a 3000 metros;

2. Explicitar que os canais nas bandas 1710-1785 MHz e 1805-1880 MHz para o serviço GSM quando utilizados em altitudes superiores a 3000 metros estão sujeitos a direitos de utilização atribuídos a pedido;

3. Explicitar que os direitos de utilização atribuídos noutros países da CEPT, no contexto da Decisão ECC/DEC/(06)07, serão objecto de reconhecimento mútuo pelo ICP-ANACOM.

Lisboa, 10 de Abril de 2007

Pela OnAir,

Luís Pais Antunes

Anexo I

REGULATORY DEVELOPMENTS IN EUROPE RELATING TO GSM ON BOARD SYSTEMS AS OF Q1 2007

The following is a status report on the key regulatory developments relating to the GSM onboard ("GSMOB") system that have occurred in Europe in the past several months. Through the efforts of OnAir and others who are supporting the effort, substantial progress has been made towards achieving eventual aviation safety approvals as well as spectrum authorizations where required.

This status report covers three areas: (1) regional and international developments, (2) national approaches to spectrum authorization and mutual recognition within Europe, and (3) OnAir's revised deployment timescale, which now anticipates commercial launch of the service during 2Q or Q3 2007.

1. Regional and International Developments

CEPT /ECC: On approving the results of the GSM onboard Aircraft compatibility study[1] that was presented at the CEPT/ECC/WGSE meeting in September 2006, the ECC issued a Decision (06) 07 adopting the technical annex at the ECC meeting December 2006. The CEPT/ECC decision endorses the principle of mutual recognition; that is, a service provider may exploit a GSM base station in an aircraft above 3000 metres in all CEPT member countries on the condition that the country where the relevant aircraft is registered permits such spectrum use and on the condition that the service provider observes the technical and operational conditions of the annex to the decision. ETSI: Based on the conclusions of TCAM that the NCU (when used in conjunction with the pico cell and only for offering service onboard aircraft) does not constitute a jamming device and that the system satisfies the R&TTE Directive, ETSI has been developing the harmonised standard (EN) of the GSM onboard system. The GSMOBA group was created from the parent groups ETSI ERM and ETSI MSG. The content of the EN is almost complete and will soon be sent out for public consultation. Further developments on defining a test methodology will be carried out during the coming year.

European Commission: In the summer of 2006, the Commission (via the Radio Spectrum
Committee (RSCOM)) mandated the CEPT to carry out technical compatibility studies on Mobile Communications on board aircraft (MCA). In response, the ECC issued a draft version of the report in December 2006, and the final report will be delivered 1st April 2007. The results of these studies will be incorporated within the EU framework. The RSCOM is open to a flexible approach to the subject and views "mutual

recognition of licensing arrangements by each country" to be the premise for efficient regulation of this inherently international service..

A joint working group of the RSCOM and CoCom is reviewing regulatory issues such as harmonisation. Aviation Regulatory Developments: Aeronautical regulatory requirements, fulfilment of which is an important prerequisite for launch of the service, are being addressed in parallel with the telecommunications regulatory process. OnAir expects that EASA will grant airworthiness certification for use of the system on Airbus aircraft during Q2 2007. Operational issues and procedures are simultaneously being addressed by national aviation authorities with jurisdiction over the aircraft involved.

2. National approaches to authorisation in Europe

OnAir's commercial "soft launch" is scheduled for Q2 or early Q3 2007. For the first phase of service launch, OnAir has applied for spectrum authorisations in 10 countries, and OnAir is making good progress in most countries. Spectrum authorisations permitting OnAir to begin at least limited commercial services have been secured in Austria, Belgium, Germany, Italy, Luxembourg, Poland and The Netherlands. Switzerland, France and Spain are still pending, and it is expected that authorities in the latter two will issue authorisations before the end of Q2. A brief description of the status in each of the ten countries follows.

The Netherlands. The Netherlands has initiated a consultation on its proposal to modify the national frequency plan to address the GSMOB service. With this change, the principle of mutual recognition as referred to in the ECC decision (06) 07 will be implemented. The proposal is that no permit will be required for the exploitation of a GSM base station in an aircraft operating in Dutch airspace when the aircraft is flying at an altitude higher than 3000 metres from the ground. This exemption would apply to both aircraft registered under the Dutch flag and aircraft flying under the flag of another country. The consultation document makes clear that the proposed change to the National Frequency Plan 2005 would not infringe the existing rights of DCS 1800 permit holders, since the award of the licenses in November 1997 applied explicitly to *land-based* mobile systems and could not be interpreted to cover the use of a GSM base station in an aircraft flying at least 3000 metres above ground.

Poland, Luxembourg and **Austria** have all authorised commercial OnAir operations via "comfort letters" concluding that foreign registered aircraft licensed to carry the service in their countries of registration will be "mutually recognized" in terms of spectrum authorizations.

Belgium. Commercial license has been issued. Note that the legal dispute between Mobistar (Orange) and BIPT that emerged in November 2006 has now been resolved. Mobistar withdrew the case in February 2007.

Germany, Italy and Spain. Trial or experimental licenses have been issued in Germany and Italy which will allow limited commercial operations onboard national or foreign-registered aircraft. BNETZA expects to authorise OnAir a full commercial access to spectrum for both German registered aircraft and non-registered by August 2007. Lead time is owed to the necessary consultation phase. The Italian Ministry has indicated

that it will upgrade OnAir's experimental license to a temporary license, and Spain is expected for follow a similar approach to Italy's.

In **France,** ARCEP have informed us that they will work on paving the way for a spectrum authorization to permit commercial launch of GSMOB service in parallel with the aeronautical authorizations that must be obtained, which are expected before end Q2 2007.

In **Switzerland**, OnAir was authorized to undertake an engineering flight test and cooperated with BAKOM in connection with ground tests to check for harmful interference with terrestrial networks. It is hoped that a change in the Telecommunications Ordinance expected to take effect in April 2007 will pave the way for commencement of a process for the grant of a spectrum authorisation for commercial exploitation of the GSMOB service.

3. OnAir roll-out plans

There have been some significant changes in the planned rollout for the OnAir service in Europe during Q1 2007. The revised schedule is a result of additional considerations that need to be addressed as part of the airworthiness certification process, and consideration of aeronautical operational aspects. In order to resolve the operational issues, a joint task force dedicated to the launch of the AirFrance aircraft and involving AirFrance, the French National Aviation Authority (DGAC), Airbus and OnAir has been created. This task force will develop an operational solution that satisfies the applicable aeronautical regulations.

Engineering and RF testing
OnAir and Airbus are in the process of carrying out the necessary tests to ensure that the system works correctly and consequently a number of flight tests are to be carried out. The first of such tests were carried out between 29 January – 5 February. A highlight report of this is available on request.

AirFrance
Airbus has already installed the equipment in the Airbus aircraft (A318) that will make mobile phoning on board the aircraft possible for AirFrance. AirFrance have requested to have an initial test phase as a so called commercial test period where the impacts of introducing the GSM service (first data and later voice) will be assessed. The expected commencement of this service is end 2Q 2007 or early Q3.

Ryan Air
Ryan Air is still on track to provide a commercial service in 2007. It is anticipated that within two years, the equipment necessary to make mobile phoning in the aircraft possible will be installed in all the company's Boeing 737-800 aircraft. The expected entry into service date is end Q3 2007

TAP Airlines Portugal
TAP announced that it will conduct tests for commercial use of mobile telephone systems on board its aircraft (Airbus 321). The tests will begin when the equipment developed by Airbus, Siemens and other partners is certified and the regulatory

framework is in place and that the aircraft is available for installation. The expected entry into service date is Q4 2007

British Midlands (bmi)
BMI is also planning to trial the system with a tentative installation timetable of early 2008.

Anexo II

ECC Decision
of 1 December 2006

on the harmonised use of airborne GSM systems in the frequency bands 1710-785 and 1805-1880 MHz

(ECC/DEC/(06)07)

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that every state has sovereignty over the airspace[1], including the radio spectrum, above its territory;

b) that ECC adopted its Report 093 "Compatibility between GSM equipment on board aircraft and terrestrial networks";

c) that the frequency bands 1710-1785 and 1805-1880 MHz are allocated to the mobile service on a co-primary basis in the ITU Radio Regulations;

d) that within Europe the frequency bands 1710-1785 and 1805-1880 MHz have been designated for GSM;

e) that a system (i.e. the equipment necessary to establish a GSM 1800 MHz pico-cell system onboard an aircraft and to prevent a direct connection of the onboard GSM mobile terminals with mobile networks on the ground, "the System") can enable the use of GSM mobile terminals onboard an aircraft during flight;

f) that appropriate measures should be taken to ensure that onboard terminals are switched off when the airborne GSM system is not in operation and that mobile terminals not controlled by the System (such as those from professional mobile networks) remain switched off during all the phases of the flight;

g) that, provided the power levels and frequency bands used by the System are suitably controlled and that mobile terminals onboard an aircraft in flight are prevented from attempting to register with mobile networks on the ground, and can only register with the onboard System, it is possible to ensure that there is no harmful interference to systems operating outside the aircraft;

h) that the effect of the System can be confined within the aircraft, facilitating the efficient use of spectrum;

i) that, without prejudice to the minimum height requirements set out in the Annex, administrations may place additional height or geographic restrictions on the operation of the System over their territory, depending on the terrain and related network deployments in a country;

j) that for the purposes of this Decision the aircraft cabin space is considered to be subject to the control of the country of aircraft registration and the System will only be used within the aircraft;

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1 This defined as:- the space above a particular national territory, treated as belonging to the government controlling the territory. It does not include outer space, which, under the Outer Space Treaty of 1967, is declared to be free and not subject to national appropriation.

k) that accordingly responsibility for the authorisation of the spectrum utilised onboard an aircraft by the System will be that of the country of registration of the aircraft, in accordance with that country's authorisation regime;

l) that the use of the relevant frequencies will be authorised by one administration but those frequencies could also be used within the airspace of other countries;

m) that the installation and use of the System within the aircraft will be subject to regulation, including airworthiness certification, by the relevant aviation authorities and the System cannot be put into operation until it complies with these requirements;

n) that the communication link between the System and the ground is outside the scope of this Decision;

o) that all necessary measures should be taken to monitor that the System and its installation conform to the relevant technical parameters given in the Annex;

p) that, despite measures to ensure avoidance of harmful interference referred to in considering g), h), i) and o), it may remain necessary for administrations to assist each other with the resolution of reports of interference in a timely manner, in accordance with appropriate ITU procedures;

q) that the System provides an electronic communication service to GSM mobile terminals inside the aircraft during flight;

r) that this Decision shall not impede EU/EFTA countries from fulfilling their obligations according to Community laws;

DECIDES

1. that administrations shall allow the use of the System within the frequency bands 1710-1785 and 1805-1880 MHz provided that the System operator is authorised to operate the System (including the right to use the necessary spectrum) by the country of registration of the aircraft and in accordance with the restrictions referred to in considering i);

2. that the System shall not cause harmful interference to, or claim protection from, any other authorised system;

3. that the use of the System shall comply with the technical and operational requirements set out in the Annex;

4. that this Decision enters into force on 1 December 2006;

5. that the preferred date for implementation of the Decision shall be 1 June 2007;

6. that CEPT administrations shall communicate the national measures implementing this Decision to the ECC Chairman and the Office when the Decision is nationally implemented;

7. that CEPT administrations shall communicate to the ERO any additional national measures supplementing this Decision in accordance with considering i), which shall be then made publicly available on the Office web site (http://www.ero.dk)."

ANNEX

TECHNICAL AND OPERATIONAL REQUIREMENTS FOR AIRBORNE GSM SYSTEMS

A.1 DESCRIPTION OF THE AIRBORNE GSM SYSTEM

The onboard GSM mobile system (the System) enables airline passengers to use their personal mobile terminals during approved stages of flight. GSM access onboard aircraft is provided by one or more pico cell BTS (aircraft-BTS). Onboard mobile terminals must be prevented from attempting to access networks on the ground. This could be ensured:

- By the inclusion of a Network Control Unit (NCU), which raises the noise floor inside the cabin in mobile receive bands and/or;
- Through RF shielding of the aircraft fuselage to further attenuate the signal entering and leaving the fuselage.

The power of the onboard GSM mobile terminals is controlled to the minimum value by the aircraft-BTS. The aircraft-BTS operates in the GSM 1800 frequency band. This band has been selected because the minimum transmit power of the mobile terminal is lower than for the GSM 900 band and the path loss is higher for the 1800 MHz band.. The NCU power must be sufficient to remove "visibility" of the networks located on the ground, whilst not being so high as to cause harmful interference to these networks. Similarly the power of the aircraft-BTS should be sufficient to provide a reliable service, without causing harmful interference to networks on the ground.

The terrestrial networks protected are those operating in frequency bands:

- 450-470 MHz
- 876-915 MHz / 921-960 MHz
- 1710-1785 MHz / 1805-1880 MHz
- 1920-1980 MHz / 2110-2170 MHz

Other frequency bands (such as the 2500-2690 MHz band) might need to be addressed in the future.

This decision applies to operation of the System at a minimum height of 3000 m above ground.

A.2 PREVENTION OF MOBILE TERMINALS FROM ATTACHING TO NETWORKS ON THE GROUND

During the period when the use of GSM mobile terminals is authorized on an aircraft, terminals operating within the frequency bands defined in table 1 shall be prevented from attempting to register with networks on the ground.

Frequency band (MHz)	Considered systems on the ground[2]
460-470	CDMA2000, FLASH OFDM
921-960	GSM, WCDMA
1805-1880	GSM, WCDMA
2110-2170	WCDMA

2 The parameters of the considered victim systems were used when defining the limits described in this annex; see ECC report 93 for the values assumed in the studies.

Table 1

If an NCU is used, the noise power radiated by the NCU must be sufficient to prevent terminals from receiving and connecting to networks on the ground, while also meeting the requirement, described in the section A.3, for maximum power radiated from the aircraft in mobile receive bands[3].

A.3 E.I.R.P FROM THE NCU/AIRCRAFT-BTS, OUTSIDE THE AIRCRAFT

The total e.i.r.p, defined outside the aircraft, resulting from the NCU/aircraft-BTS shall not exceed[4]:

Height above ground (m)	**Maximum e.i.r.p. produced by NCU/aircraft-BTS, outside the aircraft in dBm/channel**			
	Band: 450 MHz	**Band: 900 MHz**	**Band: 1800 MHz**	**Band: 2 GHz**
	Channel Bandwidth=1.25 MHz	**Channel Bandwidth=200 kHz**	**Channel Bandwidth=200 kHz**	**Channel Bandwidth=3.84 MHz**
3000	-17.0	-19.0	-13.0	1.0
4000	-14.5	-16.5	-10.5	3.5
5000	-12.6	-14.5	-8.5	5.4
6000	-11.0	-12.9	-6.9	7.0
7000	-9.6	-11.6	-5.6	8.3
8000	-8.5	-10.5	-4.4	9.5

Table 2

It should be noted that the limits, defined in the table 2, are dependant on the elevation angle at the victim terminal on the ground (see the attachment to this annex). The values contained in the table are for the case where the victim terminal is directly below the aircraft, and are therefore conservative.

A.4 E.I.R.P FROM THE ONBOARD TERMINAL OUTSIDE THE AIRCRAFT

The e.i.r.p, defined outside the aircraft, resulting from the GSM mobile terminal transmitting at 0 dBm shall not exceed[5]:

Height above ground (m)	Maximum e.i.r.p, defined outside the aircraft, resulting from the GSM mobile terminal in dBm/channel
	1800 MHz
3000	-3.3
4000	-1.1
5000	0.5
6000	1.8
7000	2.9
8000	3.8

Table 3

3 If these two requirements cannot be simultaneously met for a particular aircraft height, the minimum height for the operation of the System must be increased.

4 The values quoted in the tables 2 and 3 correspond to a maximum increase of the receiver noise floor 1 dB (i.e. I/N ≤ -6 dB) with a high statistical confidence using the most sensitive types of base stations and terminals.

5 The values quoted in the tables 2 and 3 correspond to a maximum increase of the receiver noise floor 1 dB (i.e. I/N ≤ -6 dB) with a high statistical confidence using the most sensitive types of base stations and terminals.

It should be noted that the limits, defined in table 3, are dependant on the elevation angle at the victim base station on the ground (see the attachment to this annex). The values contained in the table correspond to an angle of elevation of 2°, which are conservative.

A.5 MINIMUM HEIGHT FOR OPERATION

The absolute minimum height above ground for any transmission from the system in operation shall be 3000 metres. However, this minimum height requirement could be set higher, in particular:

- in order to comply with the aircraft-BTS and the onboard terminals emission requirements set in previous sections,
- depending on the terrain and related network deployments in a country.

A.6 OPERATIONAL REQUIREMENTS

The aircraft-BTS shall control the transmit power of all GSM mobile terminals, transmitting in the GSM 1800 band, to the minimum nominal value of 0 dBm at all stages of communication, including initial access.

It is necessary that appropriate measures are taken to ensure that onboard terminals are switched off when the airborne GSM system is not in operation and that mobile terminals not controlled by the System (such as those from professional mobile networks) remain switched off during all the phases of the flight.

ATTACHMENT TO ANNEX: IMPLEMENTATION CONSIDERATIONS

Considerations for design/installation of systems

The requirements for operation of an Airborne GSM system, which would ensure avoidance of interference into terrestrial networks, are highly dependent on many factors of the System, including the aircraft size and type, its RF isolation characteristics, propagation characteristics within the cabin and the installation of the onboard system.

Defining the emissions requirements outside the aircraft (as given in A.3 and A.4) has the following advantages:

- The limits are independent of the aircraft type and technical characteristics, such as size, fuselage construction and its RF shielding features, etc;
- The limits are technology neutral as they would not assume a specific type of installed Airborne GSM system (e.g. whether system uses NCU or not, what type of antennas are used for aircraft-BTS, etc);
- The manufacturers and operators of Airborne GSM systems have freedom to trade-off different elements of technical system design and choice of installation for achieving compliance with the limits, such as:
    - variation of the output power of NCU/aircraft-BTS inside the cabin depending on the fuselage attenuation;
    - choosing for the NCU/aircraft-BTS an appropriate antenna type, number and their placement so as to achieve the most efficient coverage along the cabin while limiting radiation outside the aircraft;
    - evaluating more precisely the propagation characteristics inside the cabin, e.g. variation of signal strength due to the layout of the cabin, and factoring this into the evaluation of emissions radiated outside the aircraft, and so on.

Administrations wishing to authorize the operation of Airborne GSM systems may require that documentation describing the evaluation of installation be provided as part of the authorization of the Airborne GSM system. Additionally, administrations authorizing the GSM onboard systems should also consider various mitigation factors such as the distribution of the carriers over the authorized band.

Some factors that might be considered as part of a detailed evaluation are briefly summarized in the following sub-sections.

Further detailed information on these issues is available in ECC Report 93.

Attenuation by aircraft fuselage

The aircraft attenuation is a very important factor when considering how the emission limits outside aircraft should relate to the actual parameters of the Airborne GSM system equipment installed onboard an aircraft (notably output power for the NCU/aircraft-BTS and their antenna type and radiation characteristics). However this factor is highly dependant on the individual aircraft features such as its size, fuselage construction and material, number of windows, etc. Therefore it is impractical to find a single precise relationship (analytical or empirical formula), which would be applicable to all aircraft makes/types.

It is envisaged that the manufacturers/operators will be able to evaluate with a reasonable degree of precision the fuselage attenuation of each particular aircraft type where the Airborne GSM system is

intended to be used and thus would be able to relate the emissions limits outside aircraft with the equipment parameters and emission limits inside that particular aircraft.

Elevation angle at ground victim receiver

- The studies described in ECC Report 93 demonstrate that the limits for maximum radiation from Airborne GSM system in order to protect ground networks would depend on the elevation angle at which the ground victim receiver sees the interfering aircraft. This is due to the fact that for a given height, two factors vary inversely with the elevation angle to the aircraft: the lower the elevation angle, the higher the distance to the aircraft and the larger the free space path loss; but
- the lower the elevation angle, the higher the victim receiver antenna gain of the ground BTS.

Since the elevation angle will change as the aircraft flies over terrestrial base stations, the worst case elevation angle is assumed when deriving the radiation limits given in the annex.

If the radiation pattern of the aircraft is known, this information could be considered when defining the emission limits for a specific aircraft type and installation (e.g. positioning of NCU/aircraft-BTS antennas in relation to aircraft windows).

More information on this issue (incl. the graphs for emissions limits as a function of elevation angle) can be found in section 8 of ECC Report 93.