CEPT Report 16

Report from CEPT to the European Commission
in response to the EC Mandate on

Mobile Communication Services on board aircraft (MCA)

Final Report on 30 March 2007 by the:

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

0 EXECUTIVE SUMMARY

This final report considers the impact of Mobile Communication Services onboard Aircraft (MCA) to ground-based mobile networks. The study assumes the operation of the MCA system at a height of at least 3000 m above ground level in the 1800 MHz frequency band (1710-1785 MHz for uplink (terminal transmit, base station receive) / 1805-1880 MHz for downlink (base station transmit, terminal receive)).

The MCA system considered in the report consists of a Network Control Unit (NCU) to ensure that signals transmitted by ground-based mobile systems are not visible within the cabin and an aircraft BTS (ac-BTS) which provides the connectivity. Combined they are designed to ensure that the mobile stations on board the aircraft (ac-MS) only transmit at the minimum level of 0 dBm nominal value with a 0 dBi antenna gain and are not able to connect directly to ground based mobile networks. The parameters for the NCU and ac-BTS were derived from theoretical models.

The following ground based mobile networks have been addressed: GSM900, GSM1800, UMTS900, UMTS1800, UMTS in the 2 GHz FDD core band and CDMA-450/FLASH-OFDM (CDMA2000/ FLASH-OFDM at around 450 MHz).

CEPT recognizes that the avoidance of harmful interference which might endanger the functioning of aviation-related safety services takes priority over any other issue. **However, this report will not address the regulatory and operational aspects or EMC issues related to the aircraft avionics, since these issues are outside CEPT responsibilities.**

For the estimation of the impact on the ground based mobile systems, two methodologies have been used: the worst case methodology MCL (Minimum Coupling Loss) and simulations with SEAMCAT[1] taking into account random distributions of the aircraft around a receiver on the ground. The free space path propagation model was used between the aircraft and ground based mobile networks for all interference scenarios. Inside the cabin, a leaky feeder antenna was assumed.

The studies were based on typical values of network equipment parameters (as provided by manufacturers and operators) where available. Otherwise, reference values extracted from the standards were used.

The studies have demonstrated that the maximum values of the radiations from the MCA system, in order to protect ground networks, depend on the elevation angle at which the ground victim receiver sees the interfering aircraft. Since this elevation angle changes as the aircraft flies, the worst-case elevation angles were assumed when deriving radiation limits, i.e. the victim terminal is directly below the aircraft or the victim base station is close to the horizon as seen from the aircraft.
The studies have shown that there is no significant increase of the level of interference due to MCA emissions from multiple aircraft since the dominant source of interference to a terminal on the ground is the MCA in the closest aircraft.

The attenuation due to the aircraft is a crucial factor when undertaking compatibility studies involving MCA systems, in particular when considering how the emission limits outside the aircraft should relate to the actual parameters of the MCA system equipment (notably output power for NCU/ac-BTS and their antenna type and radiation characteristics). However this factor is highly dependent on the individual aircraft features such as:

- the aircraft type/variant;
- the characteristics of the aircraft RF isolation;
- the propagation characteristics within the cabin;
- the installation of the MCA system.

To avoid harmful interference to ground-based networks (using the criterion I/N< -6 dB), the e.i.r.p. densities given in Table 1 should not be exceeded. These limits are defined as levels outside the aircraft in order to meet this objective, despite the variation in aircraft attenuation due to the factors described above.

[1] Spectrum Engineering Advanced Monte Carlo Analysis Tool developed for compatibility studies within CEPT, available from www.ero.dk/seamcat .

Minimum operational height above ground (m)	Maximum permitted e.i.r.p. density produced by ac-MS, defined outside the aircraft (dBm/ 200 kHz)	Maximum permitted e.i.r.p. density produced by NCU/aircraft-BTS, defined outside the aircraft				
		Ac-BTS	NCU			
		1800 MHz	450 MHz	900 MHz*	1800 MHz*	2GHz
		(dBm/ 200 kHz)	(dBm/ 1250 kHz)	(dBm/ 200 kHz)	(dBm/ 200 kHz)	(dBm/ 3840 kHz)
3000	-3.3	-13.0	-17.0	-19.0	-13.0	1.0
4000	-1.1	-10.5	-14.5	-16.5	-10.5	3.5
5000	0.5	-8.5	-12.6	-14.5	-8.5	5.4
6000	1.8	-6.9	-11.0	-12.9	-6.9	7.0
7000	2.9	-5.6	-9.6	-11.6	-5.6	8.3
8000	3.8	-4.4	-8.5	-10.5	-4.4	9.5

Table 1: Maximum permitted e.i.r.p. density of MCA emitting entities, defined outside the aircraft

*The reference bandwidths quoted in these columns refer to the GSM carrier spacing. However, these e.i.r.p. densities are equally applicable for the protection of UMTS (WCDMA) networks.

To summarize, this report defines the conditions under which MCA can be operated, with a minimum height of at least 3000 m above ground level, without causing harmful interference to ground-based mobile networks (either in the GSM1800 band or in any other bands in which the onboard mobile terminals would be capable of transmitting). Note that in order to meet these conditions care will need to be taken over the installation and operation of the MCA system.

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1 INTRODUCTION

This is the report by the European Conference of Postal and Telecommunications Administrations (CEPT) to the European Commission (EC) in response to the Mandate on Mobile Communication services onboard Aircraft (MCA). Pursuant to Article 4 of the Radio Spectrum Decision, CEPT is mandated to undertake the work required to identify the most appropriate technical criteria for the timely and harmonized introduction of MCA applications in the European Union.

The Mandate was issued to CEPT in October 2006 (RSCom #17) and addresses the airborne GSM1800-based mobile communication systems.

This report has been developed within CEPT/ECC/WGSE Project Team 7 (SE7) with contributions from Administrations and industry. The associated report (ECC Report 093) was approved by the CEPT/ECC/WGSE meeting in September 2006.

2 ABBREVIATIONS

MCA	Mobile Communication services onboard aircraft
Ac-	aircraft- (prefix)
Ac-BTS	GSM base station located onboard
Ac-MS	GSM mobile station located onboard
Ac-UE	UMTS User Equipment located onboard
AGS	Aircraft GSM Server
Antenna pattern	refers to the modelling of formulas (e.g.: an ITU-R recommendation)
BS	Base Station
BTS	Base Transceiver Station
BW	Bandwidth
CDMA	Code Division Multiple Access
CIDS	Cabin Intercommunication Data System
e.i.r.p.	Equivalent Isotropically Radiated Power
FDD	Frequency Division Duplex
FLASH-OFDM	Fast Low latency Access with Seamless Handoff using Orthogonal Frequency Division Multiplexing.
g-	ground (prefix)
g-BS	CDMA2000 base station located on the ground
g-BTS	GSM Base Station located on the ground
g-MS	GSM Mobile Station located on the ground
g-Node B	UMTS base station located on the ground
g-UE	UMTS User Equipment located on the ground
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
Leaky feeder	A coaxial cable that is intended to act as an antenna by radiating RF power along its length. Also referred to as a radiating cable
MCL	Minimum Coupling Loss
MS	Mobile Station
NA	Not Applicable
NCU	Network Control Unit located onboard
SEAMCAT	Spectrum Engineering Advanced Monte-Carlo Analysis Tool (free software tool available from www.ero.dk/seamcat)
SGSN	Serving GPRS Support Node
SMS	Short Message Service
Terminal	General term given to a handheld device capable of connecting to a public mobile network
UE	User Equipment

Visibility	Ability of a terminal to decode the system information from a base station
VMSC	Visited Mobile Switching Center
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
WCDMA	Wide Band CDMA (UTRA FDD)

3 BACKGROUND

This report considers the impact of introducing GSM mobile communication services onboard aircraft (MCA). The purpose of this study was to investigate the compatibility between GSM equipment (and some required additional equipment) used onboard an aircraft and ground-based networks. The MCA system is assumed to operate in the GSM1800 frequency band. Nowadays, many mobile terminals are multi-band or multimode terminals. Also some studies have shown that interactions between mobile terminals located onboard aircraft and ground based mobile networks are possible. Therefore, this report addresses GSM900, GSM1800, UMTS900, UMTS1800, UMTS in the 2GHz FDD core band and FLASH-OFDM/CDMA450 (FLASH-OFDM/CDMA2000 at around 450 MHz) ground based mobile networks.

Figure 1 shows an example of such a MCA system: an onboard cell is linked to backbone networks via a satellite link.

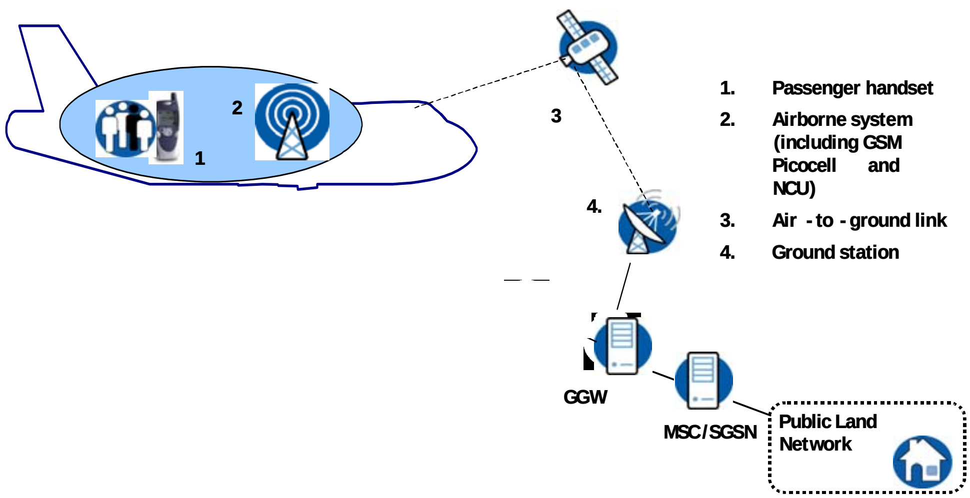

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Figure 1: Overview of the MCA system and associated components

3.1 Service description

MCA services would allow airline passengers to use their personal mobile terminals during approved stages of flight. Passengers can make and receive calls, send and receive SMS text messages and use GPRS functionality. The system provides a roaming GSM visited network access.

3.2 Service environment

MCA services are to be deployed in aircraft intended for both national and international flights. Various ground based mobile networks are deployed in those countries. It is highlighted that:

- The frequency band used for onboard communications is the GSM1800 frequency band;
- The vast majority of user terminals are multi-band or multimode, so they are able to transmit in other frequency bands and / or technologies (GSM900, UMTS 2 GHz, etc.).

The system adopted for MCA therefore is designed to ensure that user terminals on an aircraft are unable to attempt to connect directly to ground-based mobile networks, whilst providing onboard connectivity. When there is no onboard service, passengers must switch off their mobile terminal in order to prevent direct connections to ground-based networks.

3.3 Mobile frequency bands and systems covered

Connectivity (ac-MS/ac-BTS):

The ac-BTS provides the communication access to the ac-MS and supports all necessary system features like radio access and radio resource management. The study assumes that the MCA system covers the following frequency bands for connectivity between the mobile terminals located onboard an aircraft (ac-MS/ac-UE) and the onboard aircraft Base Station Transceiver (ac-BTS):

- 1710-1785 MHz and 1805-1880 MHz (GSM1800)

Control (e.g. NCU):

To prevent interaction with ground-based mobile networks, the MCA system must cover the following frequency bands (e.g.: via Network Control Unit (NCU) operation):

- 460-470 MHz (CDMA450 / FLASH-OFDM downlink band)
- 921-960 MHz (GSM900 (including GSM-R) and WCDMA (UMTS 900) downlink band)
- 1805-1880 MHz (GSM1800 and WCDMA (UMTS1800) downlink band)
- 2110-2170 MHz (WCDMA (UMTS) 2 GHz FDD core band downlink).

The report is limited to the above mentioned frequency bands and systems and some further studies on fixed networks would be needed.

3.4 General architecture of a MCA system using a NCU

There are several technical and operational methods by which the electromagnetic isolation between the ac-MS/UE and the ground based mobile networks can be achieved via passive or active means, or a combination of the two. An example of an active solution is the use of a "Network Control Unit" (NCU).The complete MCA system including ground elements typically consists of an airborne and a ground segment, subdivided in two domains, see Figure 2.

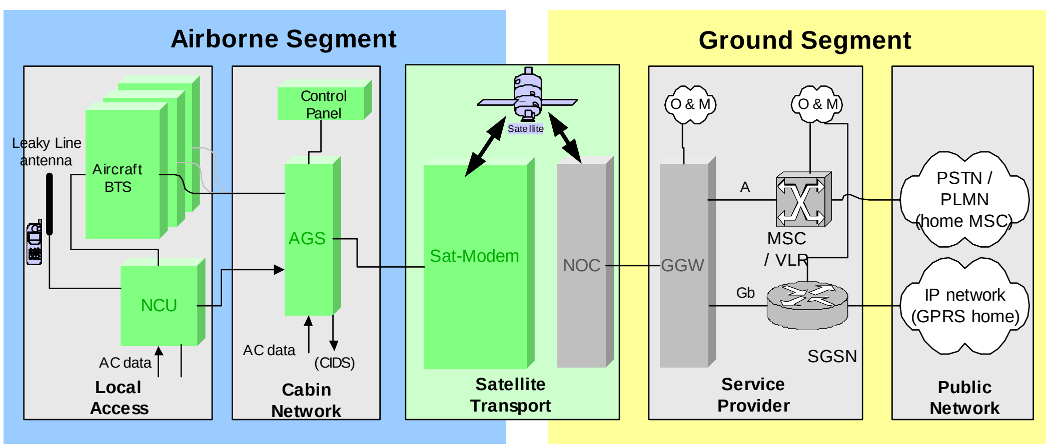

Figure 2: Overall end to end architecture of a complete MCA system

The airborne segment consists of the local access domain and the cabin network domain:

- The local access domain contains the ac-BTS and the NCU.
- The cabin network domain contains an Aircraft GSM Server (AGS) which is the interface between the main modules onboard, i.e. the ac-BTS, the NCU and the Sat-Modem.

The ground segment consists of a service provider domain and the public network domain:

- The service provider domain hosts communication controller functions that act together with the AGS functions in the aircraft. For this purpose, a Ground Gateway (GGW), and GSM visited network components (VMSC and SGSN) are required. Their main features are to perform the routing towards the aircraft, and to connect the aircraft traffic with backbone networks of the Public Network Domain;
- The public network domain provides the interconnection of the call, data or signalling communication to the relevant public network end points.

The satellite transport link connects the airborne and the ground segments.

The system description only covers the elements related to the MCA service and does not include aircraft systems, such as the avionics, as these are out of scope of this report. Note that the ground segment and the satellite transport link descriptions are for information only.

4 DESCRIPTION OF THE COMPATIBILITY STUDY UNDERTAKEN

The following provides a brief description of the work undertaken to complete ECC Report 093.

4.1 Methodology used for compatibility study

For the estimation of the impact on the terrestrial systems, two different methodologies were used: the worst case methodology MCL (Minimum Coupling Loss) and simulations using SEAMCAT[2] taking into account random distributions of the aircraft around a terrestrial station.

Free space path propagation was assumed between the aircraft and ground based mobile networks for all interference scenarios. Inside the cabin, a leaky feeder antenna was assumed.

4.2 Scenarios studied

The studies that have been carried out on the compatibility between MCA systems and ground based radiocommunication services are based on a number of assumptions relating to the characteristics of the “victim” services on the ground.

Using both models (SEAMCAT and MCL) the following six scenarios were studied:

- Scenario 1: Simulation of received signal level from ground networks into the aircraft
- Scenario 2: Simulation of received signal level at ground level of onboard mobile terminals transmitting at maximum power.
- Scenarios 3 and 4: Impact of MCA system emission (NCU and ac-BTS) to mobile terminals on the ground, for single (Scenario 3) and multiple (Scenario 4) aircraft respectively;
- Scenarios 5 and 6: Impact of ac-MS emissions to ground based mobile networks, for single (Scenario 5) and multiple (Scenario 6) aircraft respectively.

4.3 Technical parameters of MCA system

The aircraft cabin environment covers a number of parameters in order to simulate the e.i.r.p. of the aircraft seen from the ground. The two transmitting MCA entities in the aircraft are: the ac-BTS and the NCU.

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[2] Spectrum Engineering Advanced Monte Carlo Analysis Tool developed for compatibility studies within CEPT, available from www.ero.dk/seamcat .

4.3.1 Ac-BTS

The MCA connectivity component is the ac-BTS. Given that the NCU transmits contiguously across the whole band, the ac-BTS will have to transmit at a higher power level per channel.

The ac-BTS is assumed to have the following characteristics:

- Support of standard GSM and GPRS services;
- Operating in the 1800 MHz frequency band;
- Operating at a sufficient power level (at least 12 dB over the NCU power level per channel i.e.: Pico-cell (ac-BTS): e.i.r.p. for GSM 1800 MHz connectivity = The NCU 1800 MHz e.i.r.p. value (dBm) + 12 (dB)).

4.3.2 NCU

The NCU is assumed to have the following characteristics:

- No transmissions below 3000 m above ground;
- The signal generated is band-limited noise;
- The NCU transmits at dedicated minimum power to screen ground based mobile networks inside the aircraft and only transmitted above a certain height (power value dependent on frequency band and height);
- The power level may be reduced with increased height because of the decreased signal strength received in the aircraft from ground based mobile networks;
- The NCU covers the entire GSM, UMTS and CDMA2000 BTS/Node B/BS to Mobile (downlink) bands.

4.3.3 Considerations relating to operation of MCA system

The MCA system is designed to ensure that ac-MS/UE are unable to attempt to communicate with ground based mobile networks, whilst providing onboard connectivity to ac-MS in the GSM1800 frequency band.

The ac-MS transmitted power is controlled by the ac-BTS to the minimum nominal power of 0 dBm/200 kHz in the 1800 MHz frequency band.

4.4 Technical Parameters of ground based mobile systems studied

The parameters highlighted in this section reflect those used in the report. These values were based on typical values of network equipment parameters (as provided by manufacturers and operators) where available. Otherwise, reference values extracted from the standards were used.

System	Type	Bandwidth (BW) in kHz	TX Power (dBm/BW)	Maximum antenna gain (dBi)	Noise level (dBm/BW)
GSM900	MS	200	33	0	-114
	BS		43	15	-117
GSM1800	MS	200	30	0	-114
	BS		43	18	-117
UMTS 2 GHz	UE	3840	21/24*	0	-101
	Node B		43	18	-104
UMTS 900	UE	3840	21/24*	0	-99
	Node B		43	15	-103
UMTS 1800	UE	3840	21/24*	0	-99
	Node B		43	18	-103
FLASH OFDM/CDMA450	MS	1250	23	0	-101
	BS		43	18	-104

Table 2: Ground based system parameters used in ECC Report 093

* Maximum UE transmit powers values quoted to be used for the following simulations:

- Maximum UE transmission power for an onboard UE = 24 dBm;
- Maximum terrestrial UE transmission power value for simulations on the impacts for the support of voice service = 21 dBm (assumes UE power class 4);
- Maximum terrestrial UE transmission power value for simulations on impacts for the support of non voice service = 24 dBm.

Antenna gain and patterns are estimated to be similar to existing GSM/UMTS networks and terminals currently deployed.

4.5 Additional considerations used in the compatibility study

In order to carry out the compatibility study a number of additional considerations were made:

- A bespoke cylinder model was used to calculate the necessary power needed for the NCU to control the cabin environment based on the expected strongest ground signal received at the aircraft window for the various frequencies and technologies studied.
- Additional power margins were added to the model to account for in cabin RF fluctuations based on a large aircraft configuration (these margins increased the required power of the MCA system).
- The same cylinder model was used to determine the effective power radiated by the aircraft to the ground.
- Real data busy hour distributions of aircraft over a built up air space were used to calculate the impacts of multiple aircraft.
- An interference criterion of I/N< -6 dB to systems on the ground was used (equivalent to a 1 dB increase of the noise floor of the receiver).

5 RESULTS OF COMPATIBILITY OF MCA SYSTEMS ON TO NETWORKS ON THE GROUND

The results of the compatibility study showed that it is possible for onboard mobile terminals to identify networks on the ground and may be able to successfully communicate with those networks. Consequently if mobile terminals are allowed to be used in an aircraft then the environment must be created so that those onboard mobile terminals are not able to detect networks on the ground when the MCA system is operational

Assuming that an active control device is used then the report studied the impact of the:

- *NCU emissions into the Ground based Downlink (*base station transmit → mobile station receive link*);*
- ac-BTS emissions into the *Ground based Downlink* (base station transmit → mobile station receive link), at 1800 MHz only;
- ac-MS emissions into the *Ground based uplink* (mobile station transmit → base station receive link).

The results of these analyses of the MCA system have shown that the worse case simulations occur for a single aircraft using MCL analysis based on the requirements for a large aircraft simulation (wide body). Simulations on impacts due to multiple aircraft have shown that the effect is less than expected due mainly to the fact that the dominant source of interference to a terminal on the ground is that from the closest aircraft, but also because not all aircraft flying are wide body.

Results of the studies have also shown that a system can be built that both satisfies the condition to control the aircraft cabin environment (minimum power level) and provide cabin connectivity with sufficient margin (12 dB margin over NCU power) whilst not causing more than 1 dB elevation in the noise floor of the receivers of ground based mobile networks for the various frequency bands and cellular technologies studied.

Consequently the studies on the compatibility of a MCA on to ground based mobile networks, when the aircraft is at least 3000 m above ground demonstrated that harmful interference to ground based mobile networks does not occur provided that the following technical conditions are met:

- The transmit power of ac-MS must be controlled by the MCA system to the minimum value (0 dBm nominal);
- ac-MS/UE not connected to the MCA network must be prevented from attempting to connect to ground based mobile networks (in both the GSM 1800 band and other relevant frequency bands), as this would disrupt the operation of these networks and cause interference to them;
- The aircraft fuselage will attenuate the total power entering or leaking from the cabin, but it might under some circumstances also act as a directive gain. If the cabin fuselage does not provide sufficient

attenuation, an active device such as an NCU can be used to mask the signals from ground based mobile networks that enter the cabin. The power of the masking signal from the NCU must be sufficient to reliably perform this function, but must not be high enough to cause harmful interference to ground based mobile networks in any of the frequency bands in which the NCU operates.

It was found that, if these conditions are not met, the received signal strength onboard the aircraft can be high enough for an ac-MS/UE to attempt to connect directly to a ground based mobile network even when an aircraft is at a high cruising altitude (10000 m above ground).

The levels of interfering signal to ground based mobile network and received from the ground by ac-MS/UE are strongly dependent on the height of the aircraft above ground, the average attenuation due to the aircraft and the directivity of the aircraft acting as an antenna. The studies indicate that there is a fine balance between the NCU transmitting at a sufficient power level to remove visibility of the ground based mobile networks and provide g-BTS connectivity for GSM coverage, whilst not being so high that the NCU signal itself causes harmful interference to ground based mobile networks.

The attenuation due to the aircraft is a crucial factor when undertaking compatibility studies involving MCA systems, in particular when considering how the emission limits outside the aircraft should relate to the actual parameters of the MCA system equipment (notably output power for NCU/ac-BTS and their antenna type and radiation characteristics). However this factor is highly dependent on the individual aircraft features such as:

- the aircraft type/variant;
- the characteristics of the aircraft RF isolation;
- the propagation characteristics within the cabin;
- the installation of the MCA system.

To avoid harmful interference to ground-based networks (using the criterion I/N< -6 dB), the e.i.r.p. densities given in Table 3 should not be exceeded. These limits are defined as levels outside the aircraft in order to meet this objective, despite the variation in aircraft attenuation due to the factors described above.

Minimum operational height above ground (m)	**Maximum permitted e.i.r.p. density produced by ac-MS, defined outside the aircraft (dBm/ 200 kHz)**	**Maximum permitted e.i.r.p. density produced by NCU/aircraft-BTS, defined outside the aircraft**				
		Ac-BTS	**NCU**			
		1800 MHz	**450 MHz**	**900 MHz***	**1800 MHz***	**2GHz**
		(dBm/ 200 kHz)	**(dBm/ 1250 kHz)**	**(dBm/ 200 kHz)**	**(dBm/ 200 kHz)**	**(dBm/ 3840 kHz)**
3000	-3.3	-13.0	-17.0	-19.0	-13.0	1.0
4000	-1.1	-10.5	-14.5	-16.5	-10.5	3.5
5000	0.5	-8.5	-12.6	-14.5	-8.5	5.4
6000	1.8	-6.9	-11.0	-12.9	-6.9	7.0
7000	2.9	-5.6	-9.6	-11.6	-5.6	8.3
8000	3.8	-4.4	-8.5	-10.5	-4.4	9.5

Table 3: Maximum permitted e.i.r.p. density of MCA emitting entities, defined outside the aircraft

*The reference bandwidths quoted in these columns refer to the GSM carrier spacing. However, these e.i.r.p. densities are equally applicable for the protection of UMTS (WCDMA) networks.

The studies have shown that there is no significant increase in interference due to MCA emissions from multiple aircraft since the dominant source of interference to a terminal on the ground is MCA in the closest aircraft.

6 TECHNICAL CONDITION TO ALLOW THE USE OF MCA SYSTEM

The MCA 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 mobile terminals is controlled to the minimum value by the GSM 1800 aircraft-BTS. 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 frequency band. The NCU output 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.

6.1 Prevention of mobile terminals from attaching to networks on the ground

During the period when the use of mobile terminals is authorized on an aircraft, terminals operating within the frequency bands defined in Table 4 shall be prevented from attempting to register with networks on the ground.

Frequency band (MHz)	Considered systems on the ground[3]
460–470	CDMA2000, FLASH OFDM
921–960	GSM, WCDMA
1805–1880	GSM, WCDMA
2110–2170	WCDMA

Table 4 : Victim ground networks considered in the study

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 section 5.3, for maximum power radiated from the aircraft in mobile receive bands[4].

6.2 Minimum height for operation

The absolute minimum height above ground for any transmission from the MCA system in operation shall be 3,000 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,
- depending on the terrain and related network deployments in a country.

[3] The parameters of the considered victim systems were used when defining the limits described in this report; see ECC report 093 for the values assumed in the studies.
[4] If these two requirements cannot be simultaneously met for a particular aircraft height, the minimum height for the operation of the MCA system must be increased.

6.3 e.i.r.p. from the NCU/aircraft-BTS, outside the aircraft

The total e.i.r.p. density, defined outside the aircraft, resulting from the NCU/aircraft-BTS shall not exceed[5]:

Height above ground (m)	Maximum e.i.r.p. density produced by NCU/aircraft-BTS, outside the aircraft			
	460-470 MHz	921-960 MHz	1805-1880 MHz	2110-2170 MHz
	dBm/1.25 MHz	dBm/200 kHz	dBm/200 kHz	dBm/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 5: e.i.r.p. density produced by NCU/aircraft-BTS, outside the aircraft

It should be noted that the limits, defined in the Table 5, are dependent on the elevation angle at the victim terminal on the ground. The values contained in the table are for the case where the victim terminal is directly below the aircraft, and are therefore conservative.

6.4 e.i.r.p. from the onboard terminal outside the aircraft

The e.i.r.p. density, 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. density, defined outside the aircraft, resulting from the GSM mobile terminal (operating in the 1800 MHz band) in dBm/200 kHz
3000	-3.3
4000	-1.1
5000	0.5
6000	1.8
7000	2.9
8000	3.8

Table 6 : e.i.r.p. density, defined outside the aircraft, resulting from the GSM mobile terminal

It should be noted that the limits, defined in Table 6, are dependent on the elevation angle at the victim base station on the ground. The values contained in the table correspond to an angle of elevation of 2°, which are conservative.

6.5 Operational requirements

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

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

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[5] The values quoted in the Tables 5 and 6 correspond to a maximum increase of the receiver noise floor of 1 dB (i.e. $I/N \leq -6$ dB) with a high statistical confidence using the most sensitive types of base stations and terminals.

7 CONCLUSION

This report has described the conditions under which MCA systems can be operated when more than 3000 m above ground level assuming an interference criterion of up to 1 dB increase of the noise floor of ground based mobile receivers. Conformance to these conditions prevents harmful interference to ground based mobile networks (either in GSM1800 band or in any other frequency bands in which the onboard mobile terminals would be capable of transmitting).

Note that in order to meet these conditions care will need to be taken over the installation and operation of the MCA system.

ANNEX 1

MANDATE TO CEPT ON MOBILE COMMUNICATIONS SERVICE ONBOARD AIRCRAFT

DRAFT
MANDATE TO CEPT ON MOBILE COMMUNICATION SERVICES ON BOARD AIRCRAFT (MCA)

Title

Mandate to CEPT to identify the technical conditions required to ensure the compatibility of operation with existing radiocommunication services of GSM systems on board aircraft in the frequency bands 1710–1785 and 1805–1880 MHz in the European Union.

Purpose

Pursuant to art. 4 of the Radio Spectrum Decision, CEPT is mandated to undertake the work required to identify the most appropriate technical criteria for the timely and harmonised introduction of MCA applications in the European Union.

This present mandate limits itself to the study of technical compatibility of airborne GSM1800 systems with potentially affected radio services. The limitation is justified by the expectation that MCA services will be implemented using this technology at first, and therefore needs to be prioritised. Further EC mandates targeting other technologies may be prepared in the future.

In the European Union, the airworthiness of airborne GSM1800-based mobile communication systems to avoid harmful interference to aviation systems is the competence of the European Aviation Safety Agency (EASA), as is therefore not the competence of this Mandate. The avoidance of harmful interference which would endanger the functioning of aviation-related safety services takes priority over any other issue.

Justification

Allowing people to be connected everywhere at all time is a recurring theme of the policy on the Information Society and of the i2010 initiative. The development of additional means of communicating is likely to be beneficial for work productivity and for growth in the mobile telephony market. Airborne connectivity applications would be used mostly for cross-border flights within the European Union and are pan-European in nature. A coordinated approach to the regulation of such services would support the objectives of the EU Single Market for persons by facilitating cross-border travel.

Order and Schedule

CEPT is hereby mandated to undertake all required activities to assess specific technical compatibility issues between the operation of airborne GSM 1800 systems and a number of potentially affected radio services.

CEPT shall undertake this work in full awareness of and close collaboration with developments regarding the airworthiness certification of these systems by aviation safety authorities.

CEPT is mandated to provide deliverables according to the following schedule:

Delivery date	Deliverable	Subject
1st December 2006	Interim Report from CEPT to the Commission	Description of work undertaken and interim results under this Mandate.
1st April 2007	Final Report from CEPT to the Commission	Description of work undertaken and final results under this Mandate

In addition, CEPT is requested to report on the progress of its work pursuant to this Mandate to all the meetings of the Radio Spectrum Committee taking place during the course of the Mandate.

The result of this Mandate can be made applicable in the European Community pursuant to Article 4 of the Radio Spectrum Decision[2].

In implementing this Mandate, the CEPT shall take the utmost account of Community law applicable.

[2] Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJ L 108 of 24.4.2002, p.1.