

AERONAUTICAL COMMUNICATIONS PANEL (ACP)

Working Group B / C / F

**GSM On-board Aircraft
Status of Implementation and Certification**

Airbus (issue 2)

1 BACKGROUND

At the 20th Working Group B meeting of the Aeronautical Communications Panel in Montreal, Canada, a status update on the European situation on the topic of operating a GSM system on-board aircraft was given. During the meeting a number of issues were raised concerning the safe operation of such a system, frequency regulatory aspects as well as the influence of human factors on air safety related to in-flight use of mobile phones, such as acceptance of new and possibly diverging policies of using PEDs in-flight, or a potential increase of air-rage due to usage of mobile phones [1]. The WG B concluded by recommending that ICAO should oppose the use of such devices on aircraft, unless these and all other questions are satisfactorily answered (and by further recommending that ICAO should pursue one global rule applicable to all phases of flight; i.e., that the use of phones is either permitted for all phases of flight or not permitted for any phases of flight).

With this paper Airbus responds to these issues (cf. chapter 7). Airbus in collaboration with SITA¹ is developing a GSM On-board (GSMOB) System, which will be offered as an optional cabin system to its customers. This contribution provides technical insight into the system architecture of this GSMOB System, the European telecom regulation situation and the operational procedures applied for its safe in-flight operation and thereby shall provide a basis for a further assessment of air safety related questions.

**2 GSM ON-BOARD: SYSTEM OVERVIEW &
CHALLENGES FOR SAFE IN-FLIGHT OPERATION**

The major challenge with respect to safe operation of the GSMOB system is to control radio emissions of both, the mobile phones brought into the aircraft by passengers (ac-MS) and the on-board transmitters. Mobile phones on-board aircraft tend to log into compatible terrestrial cellular networks when left ON even at cruising altitudes of 10,000 m and above [2]. In these cases mobile phones generally transmit at relatively high power levels (up to 2 Watts).

¹ SITA and Airbus have initiated the joint venture OnAir. While Airbus' focus is the development of the onboard components of the system and their integration into the aircraft, SITA provides the telecommunication background. OnAir will offer the GSMOB service as a network operator to its customers.

The log-on procedure used by all mobile phones on the market today is depicted in Figure 1 below. This general procedure is independent of the cellular standard (e.g. GSM, cdma2000, WCDMA) supported by the mobile phone. In general a mobile phone will after power ON try to physically synchronize to a base station by receiving its synchronization or pilot channel. If a network is not present, the mobile phone will continuously monitor its receive bands until either its battery is empty or it is switched OFF. Note, that no transmission takes place in this case. If the mobile phone successfully detects a synchronization or pilot channel, it will establish physical synchronization to the base station. In a second step the mobile phone will scan for the associated broadcast channel, which carries the system information (e.g. network identity, frequency allocation, etc.). After these two steps have been successfully taken, the mobile phone is able to perform an “access request” to request the establishment of a signaling channel in order to register to the network. After the channel has been established data can be exchanged.

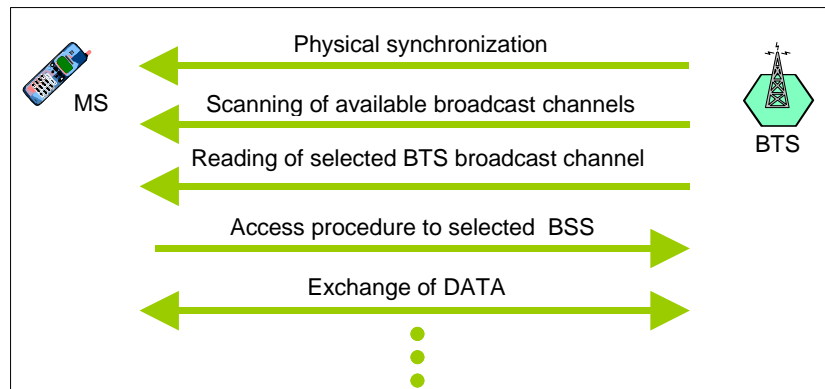


Figure 1: Log-on procedure for mobile phone systems

A well-known and thoroughly studied technical approach for controlling radio emissions of passenger mobile phones aboard aircraft is to use a Network Control Unit (NCU)¹. The aim of the NCU is to prevent ac-MSs to synchronize and attach to terrestrial cellular networks. This is usually achieved by injecting wideband noise of low power density into the relevant frequency bands, by which signals from terrestrial cellular networks are effectively screened. Thus, these networks are invisible for ac-MSs and they won't be able to synchronize and attach to on-ground networks and hence, won't be able to transmit at all. Only those mobile phones capable of connecting to the onboard Base Transceiver Station (ac-BTS) will be able to transmit in a controlled manner. The NCU is therefore a crucial part of the overall GSMOB system architecture. Furthermore, ac-MSs, when attached to the ac-BTS, will be forced to operate at the lowest possible power level. The actual power levels of the onboard system require a careful balance between the band-specific levels of noise injected by the NCU to ensure all mobiles do not attempt to connect to terrestrial networks and the maximum permitted transmission power. Details of the overall architecture and all components of the GSMOB system can be found in section 3.1 “Architecture” and 3.2 “System Components” of this contribution.

The operational states of the GSMOB system are fully controlled automatically. E.g., during take-off, climb, descent, approach and landing the ac-BTS, the NCU as well as all ac-MSs will be switched OFF in order not to interfere with terrestrial mobile phone systems on ground. For this purpose, an aircraft computer periodically sends the current altitude, position and flight phase to the GSMOB system. Specific means for passenger indication, e.g. signs, announcements, acoustic

¹ There are various other names for the NCU, e.g. On-Board Control Equipment (OBCE), On-Board Channel Selector (OBCE) or Cellphone RF Management Unit (CRFMU). All of them have the same purpose of controlling the RF emissions of mobile phones aboard the aircraft.

signals or others are introduced, in order to inform passengers when use of mobile phones is allowed and when they must be switched OFF, in accordance with the certification, operational approval and telecommunications requirements imposed by the State(s) of registry, operator, and airspace applicable to the aircraft.

3 DESCRIPTION OF THE GSM ON-BOARD SYSTEM

3.1 ARCHITECTURE

The GSMOB system typically consists of an Airborne and a Ground Segment, each of which is subdivided into two domains (cf. Figure 2).

Figure 2).

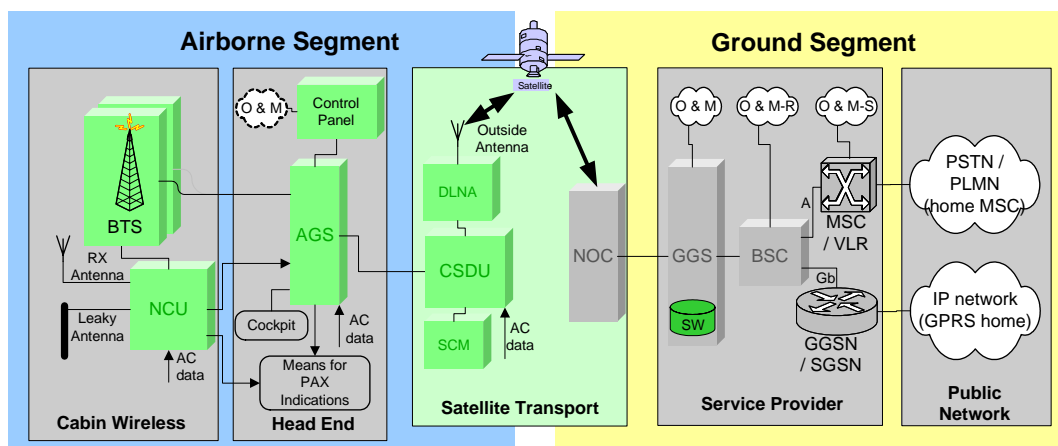


Figure 2: Overall End-to-End Architecture of the GSMOB system

The **Airborne Segment** consists of the Cabin Wireless Domain and the Head End Domain:

- The **Cabin Wireless Domain** contains one or more¹ ac-BTS(s), providing access to GSM services to passengers' ac-MSs, and the NCU controlling all phones within the aircraft cabin. The purpose of the NCU in conjunction with the BTS is:
 - a) to control radio frequency emissions of all mobile phones and
 - b) to hinder mobile phones from trying to connect to networks outside the aircraft (e.g. to terrestrial cellular networks)

Furthermore, a leaky line antenna is used for transmission from NCU and ac-BTS to the ac-MSs. For reception of the radio signals a separate receive antenna is foreseen.

- The **Head End Domain** comprises the Aircraft GSM Server (AGS) and the control panel. The AGS integrates the GSM software on-board (e.g. base station controller functionality) and interconnects the mobile phone system with the satellite modem (CSDU – Cabin Satellite Data Unit). The AGS furthermore provides the interfaces for receiving flight data as well as for providing the required signals to the CIDS. The control panel allows the crew to control the operational states of the GSMOB system.

The **Ground Segment** consists of the 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 GSM Server

¹ depending on the size of the aircraft

(GGS) is foreseen. Its main features are to perform the routing towards the aircraft, and to interconnect the aircraft traffic with terrestrial backbone networks of the Public Network Domain. For this purpose, the Service Provider Domain must host accounting and billing functions, mobility management, and routing capabilities.

- The **Public Network Domain** provides the interconnection of the call, data or signaling communication to the relevant public network end points.

The components of the Ground Segment and their descriptions are not the focus of this document.

A fifth domain (Satellite Transport Domain) connects the two segments. The satellite link provides the transportation and interconnection to terrestrial service providers and backbone networks. This domain is not part of the GSMOB system. The first GSMOB system deployed will use the Inmarsat Swift Broadband system (SBB).

3.2 SYSTEM COMPONENTS

The following gives an overview on the components of the GSMOB system, describes their purpose and characteristics. Focus is placed on the Airborne Segment only, since only this part of the GSMOB system is relevant for consideration of airworthiness, operations, airspace use, human health and telecom regulatory considerations.

Cabin Antennas

The cabin antennas distribute the RF signals in the cabin. For transmission of both the ac-BTS and the NCU the same leaky line antenna will be used. Leaky line antennas are already in use in aircraft. A leaky line antenna is essentially a coaxial cable, which has apertures in its shielding through which RF energy is radiated. This coaxial cable is installed above the ceiling panels along the whole aircraft cabin. A properly designed and installed leaky line antenna has the advantage of accurate control of the radiated field and provides a uniform linear coverage of the aircraft cabin at very low radiation power levels by propagating the RF signal mainly via the cable. Therefore, exposure to electromagnetic radiation of aircraft equipment, crew and passengers will be very low (e.g. less than 1% of already introduced Wireless LAN services within aircraft). Furthermore, this antenna type supports a wide frequency band, which is required for injecting the wideband noise signals generated by the NCU. For reception a passive dipole antenna is used.

Airbus internal tests in single aisle (A320 family) and long-range (A330/A340 family) aircraft have shown that no aircraft system is impacted by the RF signals emitted by the leaky line. These tests reflect the latest status of the work within EUROCAE WG 58 [3] and RTCA SC202.

Aircraft-BTS

The ac-BTS provides access for the ac-MS via a GSM-1800 standard compliant air interface and supports all necessary system features like radio access, power level control and frequency configuration.

The ac-BTS, for operation within Europe, has the following key characteristics:

- Support of standard GSM and GPRS services (i.e., voice, data, SMS);
- Frequency band of operation: 1710 – 1785 MHz (Uplink), 1805 – 1880 MHz (Downlink);

- Maximum transmit power level (at ac-BTS output port): 23 dBm¹

Aircraft-MS (not part of the system)

The ac-MSs are passenger-owned mobile phones operating according to the GSM-1800 standard and are not considered as part of the GSMOB system. Non-compliant phones to the GSM standard in the 1800 MHz band are prevented from transmitting via the NCU (cf. description of the NCU below). In order to keep ac-MS RF emissions as low as possible the ac-MS transmission power is controlled to its minimum power level by the ac-BTS. Link budget calculations show, that the minimum nominal power level specified for a GSM-1800 compliant ac-MS [5] is sufficient for successful communication between the ac-MS and the ac-BTS. It is understood by Airbus that for operating of intentionally transmitting PEDs, such as mobile phones, inside the aircraft cabin, relevant airworthiness standards and guidelines apply, such as ED-130 [3] and DO-294A/B [4] currently under development with EUROCAE and RTCA, respectively.

Network Control Unit

The NCU is an essential part of the GSMOB system. Its main task is to prevent all onboard mobile phones from attempting to access to terrestrial networks. These access attempts would usually cause the mobile phone to transmit at much higher power level as that used for regular communication. This is achieved by injection of broadband noise into the relevant frequency bands in which mobile phones are operated. Thus only mobile phones compatible with GSM-1800 will be able to transmit any signal while being controlled by the GSMOB system via standard GSM power control mechanisms. While there are other approaches to solve this problem, raising the noise floor in the relevant frequency bands is a very simple, effective, future-proof and well studied approach. The system developed by Airbus uses this approach.

The NCU has the following key characteristics:

- Transmission is stopped whenever the aircraft's altitude is below 3000 m above ground, operational procedures ensure that all active communications between ac-BTS and ac-MSs are stopped prior to shutting down the NCU (means for passenger indication);
- The signal generated is band-limited noise within the supported frequency bands (cf. below);
- Transmission of band-limited noise signals is kept at power levels as low as possible; power levels are dependant on the flight altitude and are set such that signals from terrestrial networks are effectively screened inside the aircraft.
- Power levels of the NCU may be reduced with increasing altitude because of the decreased signal strength received from terrestrial networks inside the aircraft;
- The terrestrial cellular bands and technologies required to be controlled will depend on where the aircraft flies. E.g. for Europe the relevant frequencies and technologies will be within the following GSM and UMTS BTS/NodeB-to-MS/UE (downlink) bands:
 - GSM- and WCDMA/UMTS-900 (921-960 MHz);
 - GSM- and WCDMA/UMTS-1800 (1805-1880 MHz);
 - UMTS UTRA-FDD 2GHz (2110 – 2170 MHz);

Figure 3 below shows an example spectrum of a noise signal generated by the NCU. In this example the 900 MHz, 1800 MHz and 2 GHz frequency bands are screened.

¹ An additional attenuation of approximately 25 dB has to be taken into account for leaky line antenna and RF combiners (required for operation of ac-BTS and NCU over the same leaky line antenna) resulting in an effective transmission power in the order of 0 dBm.

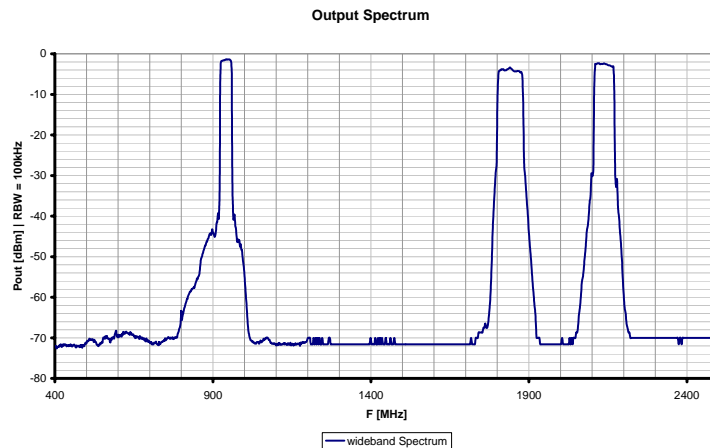


Figure 3: Example spectrum of the nose signal generated by the NCU [2].

Airborne GSM Server (AGS)

The AGS represents the central control entity of the GSMOB system. It provides the interfaces to the aircraft internal systems for retrieving relevant flight information (e.g. actual position, altitude and flight phase) as well as for controlling means for indicating admission of mobile phone use to passengers. It furthermore hosts a database, which holds geographical data. This is used to derive the altitude over ground and any location-specific system settings. The AGS further performs scheduling of data packet between the ac-BTS and the ground. It manages the satellite link communication, controls the ac-BTS, monitors the NCU output power level and manages the Operations and Maintenance (O&M) functions.

Control Panel

The control panel is the interface, which is used by the cabin crew to manually access the GSMOB system control and monitoring functions. The control panel will display relevant system information, including the status indication (ON/OFF, major or minor failure). Furthermore, it provides the push button to activate and deactivate the “night mode”. In “night mode” only data and text-based services such as GPRS or SMS are possible, while all voice services are prevented, to create recovery periods during which passengers are able to sleep undisturbed.

Cockpit Button

The cockpit button will be installed for the flight crew in an overhead panel, reachable for both, pilot and first officer. This push button gives the cockpit crew a final control over the system in the cabin. The cabin crew can only activate the mobile telephony service when the cockpit button is activated.

3.3 OPERATIONAL PROCEDURES

Throughout the following an overview on the operational procedures for a safe operation of the GSMOB system is given. Figure 4 depicts the operational states of the GSMOB system in relation to the flight phases. As soon as the aircraft’s main power bus is powered up, the GSMOB system enters the ‘IDLE’ state. In this state the components are in stand-by. The AGS and NCU continuously evaluate flight data, such as actual position, altitude and flight phase, which they receive from the aircraft’ flight computer. Neither the NCU nor the ac-BTS are actively transmitting at this stage. On the ground (e.g. on gate, or ‘Taxing Out’), the passengers will be

informed that the use of mobile phones is not allowed until the end of the ‘Take-Off’ and Climb phase. As soon as all of the following conditions hold true, the system becomes operational:

- the aircraft is in ‘Cruise’ phase (cf. ED-130 [3]),
- the aircraft’s altitude is at least 10,000 feet above the ground level (cf. [2]),
- operation of the GSMOB system is allowed according to telecom regulatory authorisation (i.e. frequency allocation and use for that country is permitted),
- the system status is not faulty (this includes the availability of the SAT-link) and
- cockpit and control panel switch are activated (ON).

At first the NCU’s transmission power levels for the various supported frequency bands (cf. section 3.2 above) are set according to the actual altitude, and its transmitter is activated. If the AGS indicates that the NCU is working properly and some holding time has elapsed, the ac-BTS transceiver will be activated to enable communication with the ac-MSs. When all system components work properly, the passenger will be informed that e.g. by announcement that the use of mobile phones is allowed. In normal flight situations the GSMOB system remains in this state. However, if the pilot or cabin crew decides, for whatever reason, to restrict the usage of the system they are able to do so by deactivating the system via the cockpit switch or the control panel, respectively. Furthermore, the crew is able to activate the “night mode” in which voice call requests are rejected and only data and text-based services (i.e. GPRS and SMS) are supported by the GSMOB system.

If the aircraft’s altitude falls below $10,000 + x$ feet above ground level, where x is a configurable margin, the passengers will be informed by e.g. a crew announcement that usage of mobile phones is not allowed. After a holding time, which allows passengers to terminate their ongoing phone calls, all active data and voice connections are terminated. Then the ac-BTS is set to stand-by by deactivating its transceiver. On descending when the aircraft’s altitude is at 10,000 feet above ground level, a trigger is generated which sets the NCU into stand-by by deactivating its transmitter. At this point the GSMOB system has returned to ‘IDLE’ state.

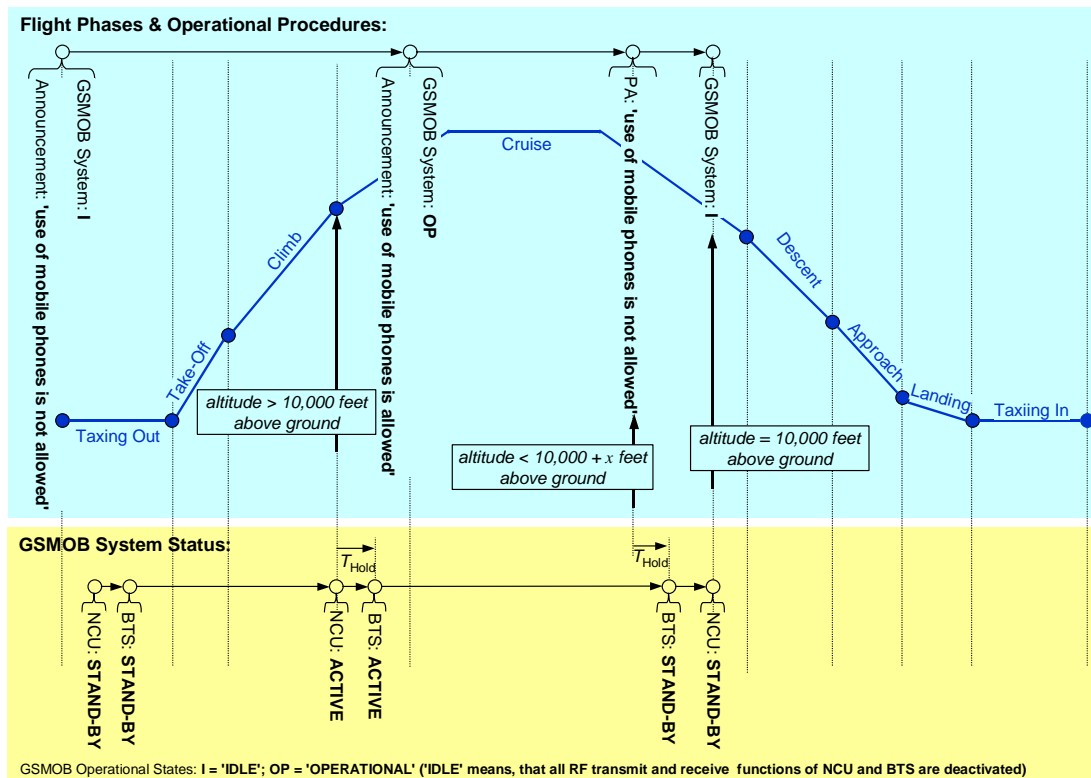


Figure 4: Flight phases, operational procedures and system states for the GSMOB system

4 AIRWORTHINESS CERTIFICATION ASPECTS

According to current regulations, the use of PEDs is only allowed during certain flight phases if their operation does not adversely affect the performance of the aircraft's systems and equipment (cf. JAR OPS 1.110 and FAR 91.21). Cellular phones are classified as intentionally transmitting devices (T-PED) and hence, are currently not allowed to be used during any flight phase (cf. OPS Leaflet No. 29). EUROCAE WG58 and RTCA SC202 are currently working on general guidelines for the use of PEDs and T-PEDs on-board aircraft. EUROCAE's work can be found in ED-130 [3], RTCA is currently updating DO294A with respect to the use of T-PEDs aboard aircraft. Both activities are carried out under close mutual consultation. ED-130 defines the demonstration procedure, which provides recommended analyses and tests that can demonstrate that a new T-PED technology will not interfere with the aircraft equipment. In general airworthiness certification of the GSMOB system on Airbus aircraft will cover the following essential aspects:

- Electromagnetic Compatibility (EMC) (JAR 25.1431),
- Effects on aircraft in failure conditions (JAR 25.1309) including effects of faulty cell phones,
- Operation Concepts (Procedures / Indications / Maintenance).

Airbus will perform all necessary verification and validation activities in order to show compliance with the applicable airworthiness requirements. The results of compliance verification activities by Airbus will be reviewed by EASA under the Certification Review Item S-37 "Installation of Onboard Cellular Telephone Systems".

5 ELECTROMAGNETIC RADIATION AND HUMAN HEALTH

The European research project “Wireless Cabin” conducted a study on potential health impacts [8]. It concludes that a mobile telephone system on board, like the Airbus system, is safe concerning human health.

6 TELECOM REGULATION IN EUROPE

6.1 FREQUENCY REGULATORY SITUATION

6.1.1 COMPATIBILITY STUDY OF CEPT ECC WGSE7

The Spectrum Engineering Working Group (SE7) of the European Communications Committee (ECC), a committee of the Conférence Européenne des Postes et des Télécommunications Administrations (CEPT), has carried out a large amount of work to study interference effects between a GSMOB system and terrestrial cellular networks. The result of this work is presented in ECC Report 93 [2], which has just passed its public consultation phase. This report serves as the technical justification for preparation of the formal decision on a harmonized use of the GSMOB system in the GSM-1800 frequency band within Europe. The actual telecommunication regulatory limits of the onboard system is defined in the technical annex of the decision which has been based on the work done in the ECC Report 93. In ECC Report 93 a number of interference situations have been defined and various aspects, such as the visibility of terrestrial networks for mobile phones aboard the aircraft and their ability to successfully access these terrestrial cellular networks have been analyzed. Furthermore, analysis has been carried out on the potential ability of the NCU and ac-BTS transmission to interfere with the downlink transmission of terrestrial cellular networks, for both a single and multiple GSMOB interfering links. Finally the impact of ac-MS transmission on the uplink transmission of terrestrial cellular networks for single and multiple GSMOB interfering links has been analyzed. For these investigations the methods of Minimum Coupling Loss (MCL) and Monte-Carlo simulations were used to derive worst-case and typical results, respectively. In all interference scenarios the cellular standards and frequency bands as indicated in Table 1 below have been considered.

Table 1: Cellular standards and their frequency bands considered in ECC Report 93

Standard	Frequency Bands	
	Downlink Band	Uplink Band
GSM900/UMTS900 ¹	921 – 960 MHz	876 – 915 MHz
GSM-1800/UMTS1800	1805 – 1880 MHz	1710 – 1785 MHz
UMTS UTRA-FDD 2GHz	2110 – 2170 MHz	1920 – 1980 MHz
CDMA450 / FLASH-OFDM	460 – 470 MHz	450 – 460 MHz

The main conclusion of this report is that it is possible to operate a GSMOB system aboard an aircraft from the perspective of compatibility with terrestrial cellular networks, taking into account the following prerequisites and conditions:

¹ includes also the frequency band reserved for GSM-R

- the GSMOB system is only activated if the aircraft's altitude is higher than 3,000 m above ground level
- the transmission power of all active ac-MSs is controlled by the ac-BTS and is always set to the minimum nominal value of 0 dBm as specified in 3GPP TS 05.05 [5]
- the power levels of the noise signals generated by the NCU are set such that signals stemming from terrestrial cellular networks are effectively screened within the aircraft's cabin, but harmful interference to these networks is not caused¹

If the above conditions are not met it is possible that a mobile phone aboard the aircraft is able to connect to terrestrial cellular networks even when the aircraft is at high cruising altitudes of 10,000 m and above.

A further conclusion of the report is that no significant increase of interference could be observed due to GSMOB emissions from multiple aircraft, if the limits identified in the technical annex are complied with.

6.1.2 ECC DECISION

Based on ECC Report 93, ECC has approved its ECC Decision (06) 07 on the harmonized use of airborne GSM systems in the frequency bands 1710–1785 and 1805–1880 MHz [6]. This decision is likely to be implemented by national European radio regulation authorities. The ECC Decision contains the limited minimum requirements and hence requires that a GSMOB system as outlined in chapter 3 above shall be operated under the conditions stated in the technical annex of the decision document.

Note:

Neither ECC Report 93 nor the ECC decision paper or its technical annex do state anything about airworthiness aspects associated with the operation of a GSMOB system and ECC does not intend to do so. The airworthiness certification is subject to the procedures and standards developed by the concerned aviation safety organizations.

6.2 HARMONIZED EUROPEAN STANDARD FOR THE GSM ON-BOARD AIRCRAFT

The Telecommunications Conformity Assessment and Market Surveillance Committee (TCAM), a committee of the European Commission, has decided that the GSMOB system can be designed to comply with the Directive 99/5/EC (the R&TTE Directive) [7]. TCAM provides assistance in the management of this directive. The R&TTE Directive establishes the regulatory framework for free circulation and operation of radio equipment and telecommunications terminal equipment within the member states of the European Union and thus states the legal objectives to be met by such equipment. TCAM stated that the GSMOB system elements are legally covered by the directive and its (the directives) mechanisms should be used to determine the requirements to place them on the market. To identify and write the subsequent test cases for the essential functionalities to meet these legal objectives according to article 3.2 of the R&TTE directive, the European Telecommunications Standards Institute (ETSI) has started the development of a harmonized European standard covering the operation of the GSM on-board aircraft. In parallel ETSI is also developing an associated Technical Specification, which specifies the requirements on performance and agreed testing approaches on the installation of the GSMOB system. The advantage of this approach is that it provides an internationally agreed approach to show

¹ the calculations given in [2] show that the NCU's power levels can be set such that this is the case

conformance of the GSM onboard system. Airbus will perform all necessary verification and validation activities in order to show compliance with the applicable telecommunications requirements. ETSI intends to put the harmonised standard for public consultation by the beginning of 2007. It has to be made clear, that the positions of TCAM and ETSI described above solely refer to the telecom regulatory aspect of operating the GSMOB system. Airworthiness aspects remain untouched and are subject to the procedures and standards developed by the concerned aviation safety organizations.

7 AIRBUS' RESPONSE TO THE QUESTIONS RECENTLY RAISED IN THE ACP

Throughout the following Airbus' response on the key issues addressed in [1] can be found. To ease readability we cite the key issues addressed by ICAO prior to responding. For clarity these citations are given in *italics*.

1) *The need for Globally Harmonized Advice/Regulation? [1]*

Without globally harmonized advice/regulation differences will appear between different regions and airlines. Given the difficulty in getting the message across to the passenger that their mobile phone needs to be turned off during flight at present the situation will only be further complicated if there are differences between regions and airlines. This could result in mobile phones being left switched on and roaming, hence operating at their highest power levels, in situations where they should have been switched off thus causing potential interference to the aircraft systems.

Airbus' response to 1)

In fact today the situation is that PEDs have to be switched OFF during certain phases of the flight whilst they are allowed to be operated in other phases. This is not different to the situation of in-flight mobile phone usage. As explained above, the GSMOB system provides means to clearly indicate to the passengers when use of mobile phones is allowed and when their usage has to be ceased..

2) *Acceptance of the 3,000 metre (10,000 feet) Radio Regulatory Limit*

CEPT is currently proposing that all mobile phone equipment will have to be switched off within 3,000 metres of the ground. The implication of this is that mobile phones will have to be switched off during take-off and landing and a variable height applied during flight dependant on the terrain over which the aircraft is flying. Can aviation accept the need for such a limitation or would aviation prefer a single decision that you can either have your phone switched on or switched off independent of the local terrain or the phase of flight.

Airbus' response to 2)

Passengers will observe only two different operational states of the GSMOB system:

- the system is active in case all conditions given in section 3.3 above hold true (these conditions include that the aircraft's altitude is higher than 10,000 feet above ground level)
- all GSM services are deactivated, which will be indicated to the passengers by illuminated by appropriate means.

Since there is this clear and simple indication to passengers, Airbus considers it acceptable to restrict the use of mobile phones to the 'Cruise' phase and an altitude above ground level of 10,000 feet or more. Furthermore, as indicated under item 1 above, passengers are used to the fact, that the use of PEDs is restricted to certain flight phases and situations. In this respect there is no difference between the GSMOB system and other PEDs which are allowed to be used in-flight already today.

3) *Differences Between Regions*

To date the work carried out within Europe has focused on GSM however there are different mobile phone systems in operation throughout the world. This raise the possibility that a phone from one region will be left on when the aircraft is in a different region again leading to the phone switching to roaming mode and thus transmitting at it's maximum power. Will this lead to a fragmentation of regulation throughout the world and hence cause a hazardous situation to occur? Also is it reasonable to permit certain phones to be used whilst other may not be and how easy will this be to enforce?

Airbus' response to 3)

All cellular mobile phone systems standardized and in operation up to now follow the principle that after power ON the mobile station first of all tries to achieve physical synchronization (in time and frequency) by searching for a defined synchronization signal. E.g., in GSM a mobile station will first of all try to receive the synchronization channel. If synchronization is successfully achieved the mobile station then tries to gather information about the identity of the network it is synchronized to by detecting the broadcast channel. After these two steps have been successfully taken, the mobile station is able to perform an initial access for establishing a call, or a location update. This access attempt and/or location updates are the critical transmissions with respect to EMI, since they are usually performed at relatively high transmission power levels.

There are two intrinsic messages included in the above explanation. First of all it is important to understand, that a correctly functioning mobile phone will never start transmission prior to physical and logical network synchronization. This means, for a mobile phone working according to a cellular standard not supported in the region (e.g. an IS95 phone using the 850 MHz band brought into Europe) there is no way that the mobile phone will start transmitting at all (neither at low nor at high power levels). This is in contrast to the assertion given under item 3 above. Secondly it is important to notice, that without taking counter measures, there is a certain possibility, that a domestic mobile phone successfully synchronizes to terrestrial cellular networks (e.g. a GSM phone within an aircraft over-flying European territory). To prevent mobile phones from being able to synchronize and attach to on-ground cellular networks a special unit will be installed within the aircraft cabin, known as Network Control Unit (NCU), cf. section 3.2 above. This unit increases the noise level within the frequency bands of the cellular mobile radio systems relevant for the region the aircraft is operated in. The NCU is designed such that the relevant frequency bands are screened by increasing the noise level to lower the Signal-to-Noise Ratio inside the cabin to such an extent that the mobile is unable to decode incoming ground BTS signals. Thus mobile phones on board the aircraft are not able to detect synchronization signals and broadcast channels stemming from terrestrial cellular networks anymore and consequently are not able to transmit at all.

4) Differences Between Aircraft

Given that not all aircraft will be fitted with a pico-cell, can aviation accept the risk that passengers will have read that mobile phones can be used on aircraft be unwilling to switch their mobile phones off when they are on a flight which is not fitted with a pico-cell.

Airbus' response to 4)

Aircraft usually vary in their cabin furnishing and the cabin services available for the comfort of the passengers. For example, only if an in-seat video system is installed passengers can watch videos with "their own" screen. Only if a data network and a network connection is installed at the passenger's seat, they can use their laptop to send emails. Consequently only if a mobile telephony system is installed on the aircraft, passengers can use the mobile telephony service. The passenger will clearly be kept informed by announcements whether and when they may use their phone, just like other personal devices, too. Additionally, for the mobile system, appropriate means will ensure that the passengers will be aware, whenever mobile phone service is available or not. To familiarize passengers with the operational procedures associated with the use of mobile phones aboard aircraft, public awareness campaigns as suggested in [3] should be carried out through concerned international bodies such as IATA and CEA. Also the distribution of place cards is an efficient way to increase passenger awareness.

5) Potential Increased Risk of Air-rage

Flying for a significant number of passengers is a stressful event. This results in passengers who in another environment would ignore a minor annoyance to be more likely to react and in some cases in a way that causes a problem to the flight. Evidence already points to the fact that the use of mobile phones in public places such as trains and restaurants by others is already seen as an annoyance by a majority of people. It is therefore feared that allowing the use of these devices on aircraft is likely to have an adverse on the number of air-rage incidence. Once the public know that you are allowed to use mobile phones on aircraft then there is also the chance of the reverse air-rage where a passenger who wants to make a phone call cannot because he is either traveling on an aircraft that is not equipped or because all the available channels are already in use.

Airbus' response to 5)

Air-rage due to mobile phone usage aboard aircraft has been considered from the very beginning of the system design at Airbus. These considerations are shown, for example by the fact that the crew is at any time able to control the operational mode of the GSMOB system via the control panel. In order to keep annoyance caused by passengers making phone calls below a reasonable limit, the crew is e.g. able to turn service "off" or to deactivate all voice services and restrict the use of the GSMOB system to text-only services (i.e. GPRS, SMS). This operational mode is known as "night-mode". Furthermore, it is conceivable that airlines arrange 'non-mobiles' zones within their aircraft where passengers are not allowed to use their mobile phones. This will reduce potential annoyance in certain areas of the cabin.

6) Interference to Aircraft Systems

Whilst test might prove that a mobile phone operating at low power will not affect aircraft systems aviation still needs to resolve whether phones which are either not compatible with the pico-cell or left on when the pico-cell is not in operation, that will be transmitting at full power can cause interference. Additionally it will have to be proven that the pico-cell can be safely attached to the aircraft's power system.

Airbus' response to 6)

The NCU, as described in sections 3.1 and 3.2 above, will take care that mobile phones are not able to synchronize to terrestrial cellular networks and start transmission. Mobile phones, which are not compatible with the pico-cell (ac-BTS) installed aboard the aircraft, will not start transmission as long as one of the following situations applies:

Terrestrial networks support standard of on-board mobile phone, but on-board pico-cell (ac-BTS) doesn't:

- ⇒ NCU screens the signals stemming from the on-ground network by introducing noise into the respective RF band(s) supported by the mobile phone aboard the aircraft. The results is that on-board mobile phones are not able to synchronize to the network and hence do not transmit.

Terrestrial networks don't support on-board mobile phone¹:

- ⇒ Since there are no terrestrial networks in reach, which support the standard supported by the on-board mobile phone, no particular action is required. This phone is not able to synchronize to a terrestrial network and hence will never try to attach. It will not start any transmission (cf. chapter 2 above).

In case the NCU needs to be switched OFF, e.g., at altitudes below 3,000 m above ground level according to the ECC recommendation [3], the usual procedures as known for PEDs (e.g. signs and crew announcements to passengers) are taken to inform passengers that they are obliged to switch OFF their mobile phones (cf. section 3.3 above).

It is self-evident that relevant EMC standards such as DO-160 apply for design of the GSMOB system, and that by following these established guidelines, it is ensured, that the on-board BTS can be safely attached to the aircraft's power system. Furthermore, the work currently carried out within EUROCAE WG 58 [3] and RTCA SC202 on the safe use of PEDs and T-PEDs aboard aircraft is carefully reflected by Airbus.

¹ E.g., as in the case when an IS95 compliant mobile phone is brought into European air-space

8 CONCLUSIONS AND RECOMMENDATIONS

This contribution provides an overview on the main components of the GSMOB system developed by Airbus and the procedures derived for its safe operation. Both, system design and operational procedures carefully reflect RTCA and EUROCAE guidelines for the use of PEDs/T-PEDs onboard aircraft. Airbus is confident to provide evidence on the compliance of the GSMOB system to all relevant airworthiness requirements and standards, such that its operation has no effect on the safety of the aircraft.

Furthermore, this contribution provides background on the telecom regulatory framework for operating GSMOB systems within Europe. We want to clearly express, that Airbus' understanding is that Telecom regulations, operational approval and airworthiness certification are separate topics, which must be addressed via their respective authority and/or regulatory bodies. Airbus actively contributes to these processes and helps to resolve remaining issues. All investigations undertaken so far by Airbus indicate that safe operation of GSMOB in Airbus aircraft is feasible. Airbus is committed to bring GSMOB into operation to provide a true benefit and a new flight experience to the passengers.

The WG B is invited to:

- Consider the above information,
- Note, that the identified issues, associated with the use of mobile phones on Aircraft, can be (and have been) addressed by Airframer's as part of their systems development, validation, verification and certification process.
- And in the light of these elements, consider updating its recommendations to ICAO and States with indications that recent advances in technology, and thorough studies of the different identified issues have permitted the development of solutions and procedures that will allow the use of mobile phones on aircraft without any adverse effect on aircraft/passenger/crew safety.

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ANNEX 1: ABBREVIATIONS

3GPP	3 rd Generation Partnership Project
ac-BTS	Base Transceiver Station aboard an aircraft
ac-MS	Mobile Station aboard an aircraft
ACP	Aeronautical Communications Panel
AGS	Airborne GSM Server
BSC	Base Station Controller
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CEA	Consumer Electronics Association
CEPT	Conférence Européenne des Postes et des Télécommunications
CIDS	Cabin Intercommunication Data System
CRFMU	Cellphone RF Management Unit
CSDU	Cabin Satellite Data Unit
ECC	Electronic Communications Committee
EDGE	Enhanced Data Rates for GSM Evolution
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute
FAR	Federal Aviation Regulations
FDD	Frequency Division Duplex
FLASH-OFDM	Fast Low-latency Access with Seamless Handoff – OFDM
GGSN	Gateway GPRS Support Node
GGW	Ground Gateway
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GSMOB	GSM On-Board
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
Inmarsat	International Maritime Satellite
IP	Internet Protocol
JAR	Joint Aviation Requirement
LED	Light Emitting Diode
MCL	Minimum Coupling Loss
MS	Mobile Station
MSC	Mobile Switching Center
NCU	Network Control Unit
NodeB	Term for Base Station in UMTS Standard
O&M	Operations and Maintenance
OBCE	On-Board Control Equipment
OBCS	On-Board Channel Selector
OFDM	Orthogonal Frequency Division Multiple Access
PAX	Passengers
PED	Portable Electronic Device
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
R&TTE	Radio & Telecommunication s Terminal Equipment
RF	Radio Frequency
RTCA	Radio Technical Commission for Aeronautics
SBB	Swift Broadband
SE	Spectrum Engineering

SGSN	Serving GPRS Support Node
SMS	Short Message Service
TCAM	Telecommunications Conformity Assessment and Market Surveillance Committee
T-PED	Intentionally Transmitting PED
TS	Technical Specification
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
VLR	Visitor Location Register