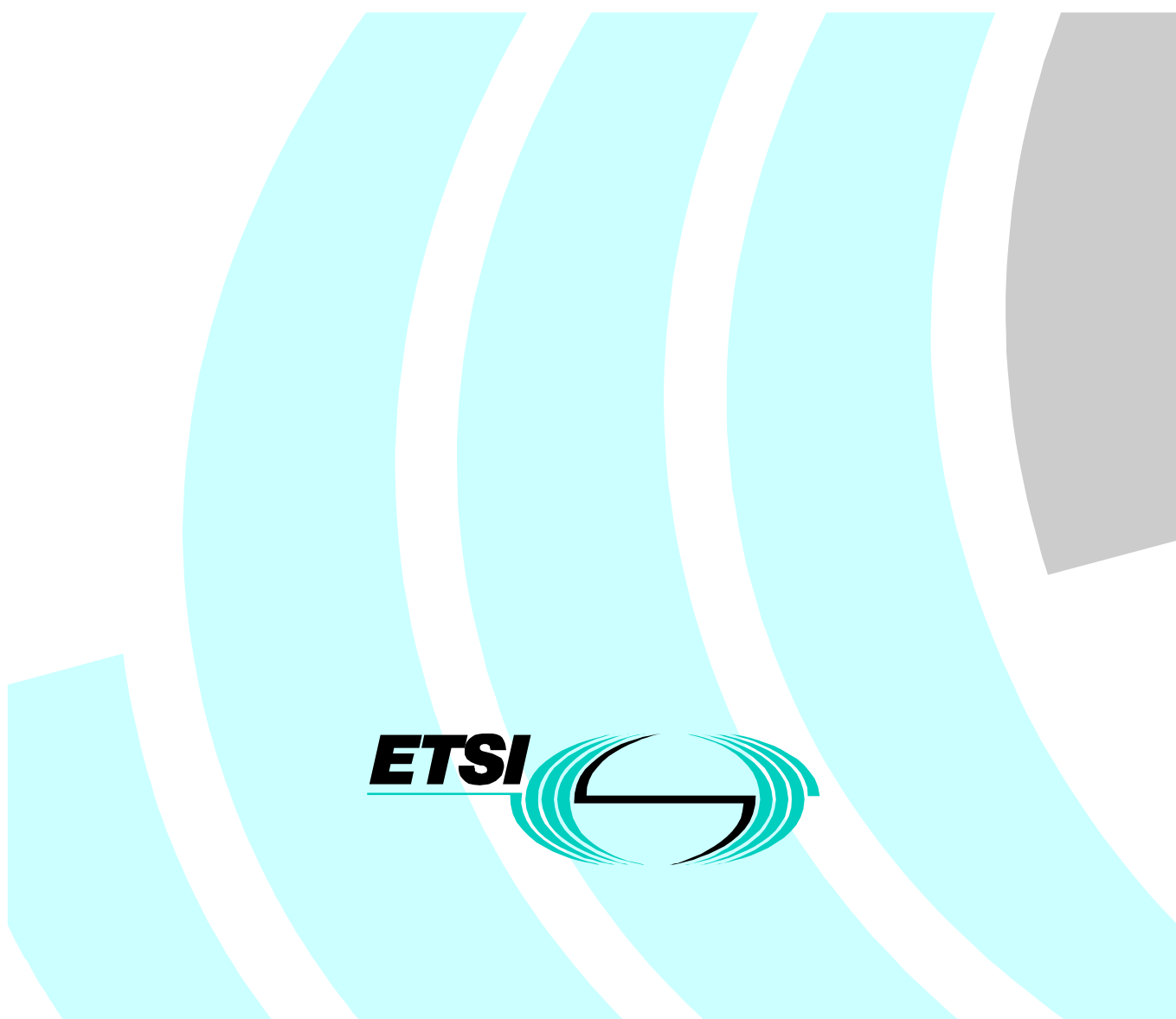


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Ground to Air calling from GSM**



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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

1 Scope

The present document defines the technical requirements necessary to implement the inter-working between Terrestrial Flight Telecommunications System (TFTS) and Global System for Mobile Communications (GSM) digital cellular communication networks. This inter-working will enable users of GSM mobile phones to place and receive calls by roaming on the TFTS network, using terminals provided on-board the aircraft. The initial services supported by the present document are speech calls and ground-to-air short message service (SMS). The specification may evolve to support fax, data and packet data services for GSM. The specification may also be developed to support the inter-connection of TFTS with other network systems.

The end-to-end system specification is based on functionality specified within ETS 300 326. The specification defines the application of this functionality and details supplementary information required on existing ARINC 746 specifications. A new TFTS GSS to Gateway Location Register interface is specified.

The initial scope and title of the present document is "Ground to Air Calling from GSM". The TS also details air to ground services, for both voice and SMS and provides an overview of how such a service can be implemented. The exact implementation of air to ground services is currently outside the scope of the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] ETS 300 326-1: "Radio Equipment and Systems (RES); Terrestrial Flight Telecommunication System (TFTS) Part 1: Speech services, facilities and requirements".
- [2] ETS 300 326-2: "Radio Equipment and Systems (RES); Terrestrial Flight Telecommunication System (TFTS); Part 2: Speech services, radio interface".
- [3] ETS 300 326-3: "Radio Equipment and Systems (RES); Terrestrial Flight Telecommunication System (TFTS); Part 3: Speech services, network aspects".
- [4] ARINC Characteristic 752: "Terrestrial Flight Telephone System (TFTS) Airborne Radio Subsystem (January 15, 1993)".
- [5] ARINC Characteristic 746-4: "Cabin Communications Systems (CCS) (April 1, 1996)".
- [6] ETS 300 901: "Digital cellular telecommunication system (Phase 2+); Technical realization of the Short Message Service (SMS); Point-to-Point (PP) (GSM 03.40)".
- [7] ETS 300 942: "Digital cellular telecommunication system (Phase 2+); Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface (GSM 04.11)".
- [8] ETS 300 900: "Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information (GSM 03.38 version 5.5.0)".
- [9] ETS 300 974: "Digital cellular telecommunication system (Phase 2+); Mobile Application Part (MAP) specification (GSM 09.02)".
- [10] GSS LR03 (May 1998): "GSS-Location Register Interface Procedures, Messages and Codes".

- [11] CCITT Recommendation E.164 (1988): "Numbering Plan for the ISDN era".
- [12] CCITT Recommendation X.25: "Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit".
- [13] CAA AIC 96/1993: "CAA Aeronautical Information Circular - Use of Portable Telephones in Aircraft".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AS	Aircraft Station
AT	Avionics Termination
ATEI	Aircraft Termination Equipment Identity
CC	Credit Card
CCM	Call Control Management
CCS	Cabin Communications System
CFB	Call Forward Busy
CFNRc	Call Forward Not Reachable
CFNRy	Call Forward No Reply
CFU	Call Forward Unconditional
DDI	Direct Dialling In
GLR	Gateway Location Register
GMSC	Gateway Mobile Switching Centre
GS	Ground Station
GSC	Ground Switching Centre
GSIC	Ground Station Identity Code
GSM	Global System for Mobile
GSS	Ground Station System
HLR	Home Location Register
IMSI	International Mobile Subscriber Identify
ISDN	Integrated Services Digital Network
LR	Location Register
LU	Location Update
MAP	Mobile Applications Part
MSC	Mobile Switching Centre
MSISDN	Mobile Subscriber ISDN
PIN	Personal Identification Number
PRN	Provide Roaming Number
PVC	Permanent Virtual Circuit
RRM	Radio Resource Management
SMS	Short Message Service
SMSC	Short Message Service Centre
SP	Service Provider
SRI	Send Routing Information
SVC	Switched Virtual Circuit
TCAP	Transaction Capabilities Application Part
TFTS	Terrestrial Flight Telecommunications System
TFTS SP	Terrestrial Flight Telecommunications System Service Provider
TO	Telecom Operator
VLR	Visitor Location Register
WOW	Weight on Wheels

4 Overview

4.1 General

The Terrestrial Flight Telecommunications Systems (TFTS) [1], [2], [3], [4] is a digital cellular radio technology, which offers communication services to aeronautical passengers. The scope of the original ETS 300 326, specifies functionality and services which enable calls to be placed in the air-to-ground direction only.

The technology specified in ETS 300 326 and ARINC 746-6 provides functionality which also enable a ground-to-air calling service to be implemented. However, additional information is needed to define the specific service which has been proposed to enable calls to be delivered from GSM to the aircraft. This technical specification details how existing TFTS and GSM functionality can be used to implement a ground-to-air calling service. The technical specification also details and defines additional functionality required.

Whilst not defined in the present document, it may be possible for users of GSM phones to have air to ground calls charged to GSM accounts.

The present document assumes the use of a magnetic stripe card to identify particular GSM user. The system may evolve to support alternative methods of user identification, including SMART cards and airline reservation systems. These methods are outside the scope of the present document.

Although the scope of the present document is for inter-working between TFTS and GSM, the infrastructure required is likely with development to be capable of supporting inter-working between TFTS and other networking systems, either fixed or mobile.

4.2 Service definition

4.2.1 Services supported

The service defined will enable users of GSM mobile terminals, to receive voice calls on-board an aircraft, via the TFTS system and airborne avionics equipment. This service will help address one of the remaining limitations on the mobility offered by GSM services, due to the restrictions that have been put in place by commercial airlines, based on requirements of Aviation Regulatory Authorities and Airframe Manufacturers [5]. The imposed restrictions prevent the use of mobile phones during flight. However, the inter-working of TFTS and GSM will enable the TFTS system to be used as a substitute to the GSM mobile handset during this period.

The services offered are:

- a) ground to air voice calls received from GSM, via TFTS system, roaming charges billed to GSM account;
- b) receiving SMS messages on-board the aircraft.

The system may enable GSM users to selectively register for speech, SMS or both services in the ground-to-air direction.

An overview of the following services is provided, although the exact technical specification for these services is currently considered as outside of the scope of the present document.

- a) air to ground calls from TFTS, with calls billed to GSM account;
- b) sending SMS messages from the aircraft.

The system may also evolve to offer GSM fax, circuit data and packet data services.

4.2.1.1 Ground to air calling

The service will enable users of GSM mobile phones to use the TFTS system as a replacement for the mobile handset when flying. To receive calls on-board, the passenger and GSM user shall first make a one-off subscription to the service. This is achieved by establishing an association between the user's MSISDN number and a magnetic stripe card number, which is stored on the GLR. Once subscribed to the service, the user may register on-board the aircraft to receive calls.

The registration shall be invoked by swiping the magnetic card through a telephone handset on-board a TFTS equipped aircraft. The passenger and GSM user shall also be presented with an option to de-register from TFTS when necessary. The passenger registration shall be passed to the GSM HLR, enabling calls destined for his mobile phone to be routed to the aircraft. The passenger shall be alerted to an incoming call by an indicator on the telephone handset and will be prompted to accept the call. The GSM user's MSISDN or other appropriate message shall be displayed on the handset and a card swipe shall be requested to authenticate the user. Roaming charges for calls received on-board the aircraft will be charged to the user's GSM account.

The system may evolve to support alternative supplementary registration methods, such as voice recognition, calling from GSM with CLI or GSM SIM card reading.

4.2.1.2 Air to ground calling

To ensure that a subscribed user is currently authorized to make mobile originated roaming calls, the user is also required to register before placing air to ground calls. On registering, the GLR obtains information from the GSM user's HLR, regarding the class of service offered. This will indicate that the user is subscribed to the home GSM network, is credit worthy and is permitted to make outgoing calls.

Air to ground calls may be validated by one of two methods;

- by a register on the CCS, which stores magnetic stripe card number, handset identity number and the GSM users class of service, provided by the GLR;
- by a data authorization transaction with the card authorization system. The status of the user's class of service will be forward to the TFTS card authorization system by the GLR at passenger registration.

The GSM users class of service will be communicated to the CCS by the cause associated with the registration DISCONNECT message (see table 5). Data authorization messages between GSS and the TFTS card authorization system will be carried out as a normal GSS call authorization function.

4.2.1.3 Short message service

4.2.1.3.1 Ground to air messaging

The system shall support the receipt of GSM short messages (SMS) by GSM users when registered onboard aircraft. SMS messages destined for the GSM user shall be automatically transferred to the TFTS system and the handset on-board the aircraft. A credit card swipe shall be required to authenticate the user before the message is displayed on the handset.

The CCS shall fully support the functionality provided by a GSM mobile station in terms of the ability to receive, process and display GSM SMS messages.

4.2.1.3.2 Air to ground messaging

The system may evolve to support air to ground SMS messaging. A ground to air message may be implemented by initiating a call set-up. The GSS/GLR shall then initiate a page channel with the AT, to receive the SMS message.

4.2.1.4 Fax and data services

The specification will evolve to support GSM fax and data services. This will be dependent on the development of TFTS fax and data services.

4.2.2 System architecture

An overview of the system architecture required to achieve inter-working between GSM and TFTS networks is shown in figure 1. The solution provides a signalling path between GSM and the TFTS Gateway Location Register (GLR), using GSM Mobile Applications Part (MAP) [9]. Call switching and transmission between GSM and TFTS is achieved through ISDN switched connections. The TFTS GLR acts as a GSM VLR and VMSC (for SMS only), manages aircraft location and passenger registration and performs signalling conversion between GSM MAP and TFTS protocols.

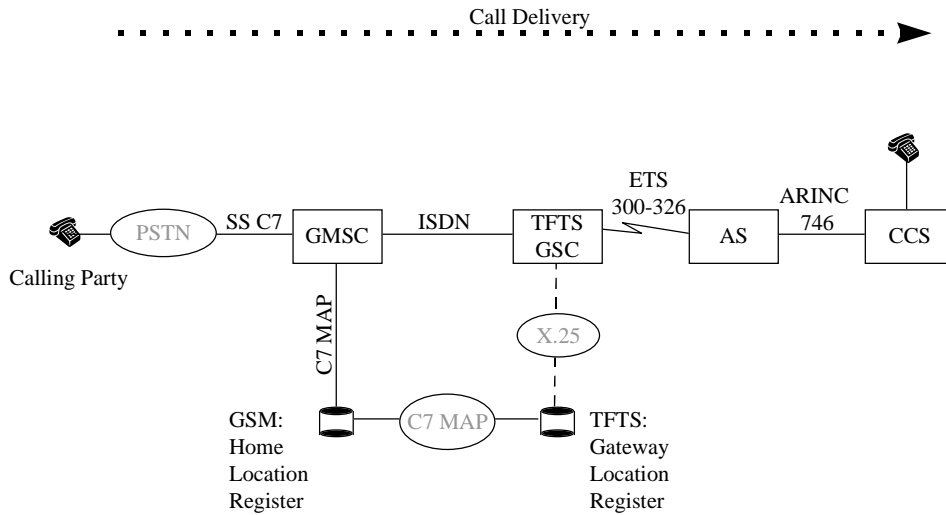


Figure 1: System architecture for GSM and TFTS inter-working

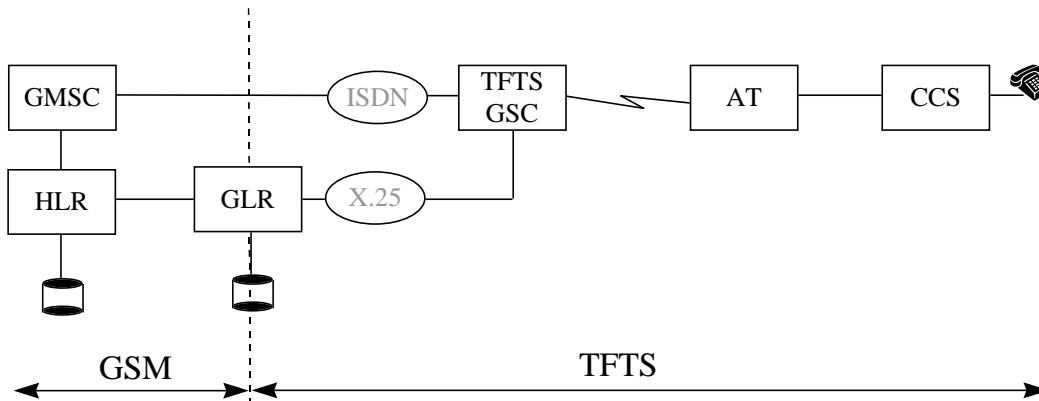


Figure 2: Scope of GSM and TFTS network elements

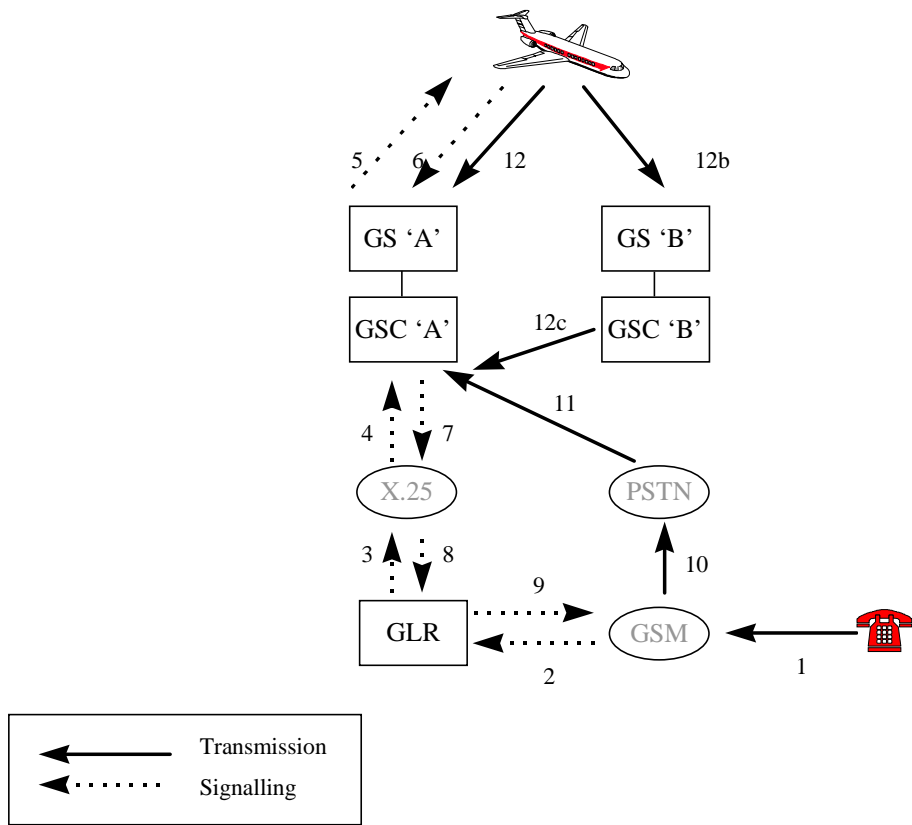


Figure 3: Signalling call flow sequence - Ground to air calling

Table 1: Ground to air call set-up actions

Reference	Action
1	Calling party dials GSM user number
2	GSM request routing number from TFTS (GLR)
3/4	Page Call Alert sent to GSS
5/6	Page Call Alert broadcast, page channel established and data sent by GSS
7/8/9	DDI routing number provided to GSM
10/11	GSM routes and connects call to TFTS
12	Aircraft establishes call to GSC DDI number
12 b/c	Alternative call routing in event of aircraft re-selecting new GS/GSC

5 Functional specification

5.1 Cabin communications system

5.1.1 General

The Cabin Communications System (CCS) provides the interface between the TFTS system and the passenger and connects the ground to air call. To enable GSM calls to be delivered to a passenger on-board the aircraft, the main functions performed by the CCS are:

- a) to enable the passenger to register or de-register to receive calls from GSM;
- b) to route incoming call requests to telephone handset;
- c) to display called party identity information on telephone handset;
- d) to collect air to ground call routing information;
- e) to complete the connection by establishing air to ground call;
- f) to enable receipt of GSM SMS messages and subsequent presentation to passengers on the aircraft handset;
- g) to enable composition and sending of GSM SMS messages by passengers (emulation of GSM mobile station functionality).

These functions utilize functionality specified within ETS 300 326-2 [2], ARINC Characteristic 746 [6], ETS 300 901 [6], ETS 300 942 [7] and ETS 300 974 [9]. The following information specifies the functions required and details how these can be utilized to implement ground to air calling. The format of additional messaging required is also detailed.

5.1.2 Passenger registration

5.1.2.1 Registration messages

Although the system may evolve to provide a variety of methods for the passenger to register to receive calls, initially passenger registration shall be carried out by requesting a magnetic card swipe. This shall initiate a call control SETUP message to the GSS, which if released successfully from the ground shall indicate a successful registration. An option will also be provided for the passenger to de-register from GSM.

The registration/de-registration SETUP message shall use the **called party BCD number** field ARINC 746 attachment 11 (ETS 300 326-2 [2] subclause 10.11.8.5.3.4) to indicate the type of registration message. The types of message are shown in table 1. This same normal call SETUP message format shall also be used for AT Location Update and call establishment of the air to ground portion of a call from GSM. Table 2 defines the coding of this field as applicable to ground-to-air calling and the interpretation of these codes. The ground to air portion of a call to GSM will use a full international number in the called party BCD number field.

Table 2: Called party BCD number

Called Party BCD Number		Type of Message	Type of Number	Numbering Plan
SP ID	Type			
XXX	10	Passenger registration (speech only)	Paging registration	Data
XXX	20	Passenger de-registration (speech only)	Paging registration	Data
XXX	30	AT Location Update - Registration	Paging registration	Data
XXX	40	AT Location Update - De-Registration	Paging registration	Data
XXX	50	Passenger registration (speech +SMS)	Paging registration	Data
XXX	60	Passenger de-registration (speech + SMS)	Paging registration	Data

5.1.2.2 Registration buffer

If a passenger attempts to register when WOW is enabled and TFTS is unavailable (on the ground and outside of coverage), the CCS shall accept the registration and store in a buffer. These messages shall be sent in sequence to the ground, once WOW is disabled AND TFTS is available.

5.1.2.3 Call alert routing to handset

In order for the ground to air call alert message to be directed to the correct handset, two methods are specified, to provide flexibility for specific implementations.

The first method is that an handset identifier number be included in the passenger registration SETUP message. The handset identifier may be included in the **called party sub-address** (ETS 300 326-2 [2] subclause 10.11.8.5.3.5). This field is specified as optional and fixed length 4 bytes binary. For the purpose of identifying **handset identifier**, sub-address information should be specified as user specific, one byte binary coded with handset identifier. The ground to air call alert PAGE message shall contain the handset identifier.

An alternative method of routing incoming call alert to handset is for the CCS to store a register of magnetic stripe cards which have been used to register, together with an associated handset identifier. In this case, the incoming call alert PAGE message shall contain the magnetic stripe number of the passenger's card which was used to register, which can be associated with the correct handset identifier.

5.1.2.4 CCS register of passengers

The CCS may be required to retain a record of passengers who have registered successfully. The register would store the magnetic stripe card number used to register and the handset from which registration took place, together with a Class of Service status indication. The Class of Service indication will be determined from the registration message release cause code. This will indicate if there are any restrictions on calling, such as international calls barred, outgoing calls barred, or calls to home country only. Once registered, authorization to place calls may be determined by the class of service field.

5.1.3 Ground to air call alert

Notification of a ground to air call (and ground-to-air SMS delivery) is received by the CCS as a PAGE request message (ARINC). The format of this message is shown in table 3.

Table 3: Ground to air page alert data format

Element	Type	Reference	Length
Type of Page	MF	Table 5	1 binary
CC Number	MF	note 1	40
Handset Identity	OF	binary	4
Routing Number	OV (note 2)	ETS 300 326 subclause 10.11.8.5.3.4	max 18
MSISDN or TEXT	OV (note 3)	ETS 300 900 [8] (GSM 03.38)	max 122
SMS Message	OV	ETS 300 901 [6] (GSM 03.40) subclause 9.2.2.1	12 to 162
NOTE 1: The page message generated by GLR formats this field as ETS 300 326 subclause 10.11.8.5.3.7.2. This format is converted by the AT to ARINC 746 subclause 4.2.5.1.			
NOTE 2: This is only included in the case of a ground to air call.			
NOTE 3: This element may be omitted in the case of ground to air SMS.			

The optional and variable length elements if used, shall be identified by the value identity code detailed in table 4. For variable length elements, the field identifier byte is immediately followed by a single byte indicating the length of element data field.

Table 4: Page data field identity codes

Element	Identity Code
Handset Identity	0000 0001
Routing Number	0000 0010
MSISDN or TEXT	0000 0011
SMS Message	0000 0100

The CC number field is 40 bytes max. If track 2 credit card data is less than 40 bytes, the remaining bytes are filled with zeros.

Once the ground to air alert PAGE is directed to the handset, the MSISDN number of the called party (or the text message included in the PAGE message) is displayed and the passenger is presented with an option to accept or decline the call (or SMS message). The GSM user's MSISDN shall be displayed for a time T_PW. If the call (or SMS message) is rejected explicitly (or the timer T_PW expires), the PAGE channel is released. If the call (or SMS message) is accepted, the passenger is prompted to swipe the magnetic swipe card, which is used to authenticate that the call (or SMS message) is delivered to the correct passenger.

The CCS is required to convert the routing number from the ETS 300 326 subclause 10.11.8.5.3.4 format, to the ARINC 746 attachment 11 subclause 4.2.4.3.

Table 5: Type of page message

Type	Application
0000 0001	Ground to air call
0000 0010	Ground to air SMS
0000 0011	Air to Ground SMS (see note)
other values	Reserved
NOTE: Air to ground SMS may not be implemented as an initial service.	

When the page channel is released, the cause codes indicated in table 6 shall detail the reason for release. These values are additional to those specified as MR-cause (ETS 300 326-2 [2] subclause 10.11.8.5.4.5).

Table 6: Page release cause codes

Cause	Meaning
0110 1001	Call accepted
0110 1010	Call rejected (user determined busy)
0110 1011	Time out of T_PW
0110 1100	Failure to connect

5.1.4 Call connect to GSS

On accepting a call, the CCS initiates a normal call control SETUP, to the routing number provided in the ground to air call alert PAGE message. The routing number is provided from the call alert page message in the format ETS 300 326 subclause 10.11.8.5.3.4. The CCS shall convert this number to the format specified in ARINC 746 attachment 11 subclause 4.2.4.3. Normal call control used for the duration of the call.

5.1.5 Ground-to-air SMS delivery

On receipt of the ground-to-air PAGE message containing the SMS message the CCS shall alert the passenger via the handset displaying their mobile number (or text message if appropriate) and on confirmation from the passenger of their willingness to accept the message display the SMS message. In doing so the CCS shall emulate the operation of a GSM mobile station (see ETS 300 901 [6], ETS 300 942 [7] for further details). The PAGE data link shall be held until the message has been read or rejected so that the necessary response/confirmation messages can be returned to the GSM network. In the case that a cell re-selection is required during this period, the page channel shall not be held for longer than T_HO, from the decision to re-select.

5.2 Avionics termination

5.2.1 General

The following functionality is required for the AT, in addition to ETS 300 326-2 [2] and ARINC Characteristic 752 [4] and ARINC Characteristic 746 [5]:

- a) Location Management;
- b) Passenger Registration Message Handling (normal call SETUP);
- c) Incoming Call Page Handling and Credit Card Number format conversion.

Location management is required to ensure that the TFTS GLR is aware of the AS location at any time. This enables incoming call PAGE messages to be directed to a target AS. The AT shall send a Location Update (LU) to the GLR whenever a new GS or GSC is selected.

The AT shall route passenger registration/de-registration messages which are initiated by the CCS to the GSS. These messages shall be handled as standard TFTS call control messages.

The AT shall monitor BCCH(D) information on the current GS in a manner which ensures a high probability of detecting a PAGE request message. On detecting a PAGE request message for an incoming call, the AT shall set-up a page channel and route the page message to the CCS. The AT shall maintain its connection with the current GS and shall not initiate handover to a new GS until the page transaction is complete. This requires the AT to defer handover or cell re-selection for a period T_HO.

5.2.2 Location management

The AT shall send a **Location Update (LU)** to the GLR whenever a new GS or GSC is selected. The initiation of an LU should be based on a configurable parameter requiring LU on either change of GS or change of GSC, which can be determined from the GSIC.

5.2.2.1 Location registration/update

When an initial GS/GSC is selected (ETS 300 326-2 [2] subclause 8.10.6), the Radio Resource Management (RRM) shall send a request for LU to the Call Control Management (CCM). On receipt of the LU the CCM shall initiate a call SETUP (ETS 300 326-2 [2] subclause 10.11.4.2. This call SETUP message shall contain "called party BCD number" (ETS 300 326-2 [2] subclause 10.11.8.5.3.4) with values listed in table 1.

On receipt of the DISCONNECT message, the CCM entity shall indicate to RRM that the LU registration has been successful. On receipt of the DISCONNECT message with an error cause, the CCM entity shall indicate to the RRM the LU has failed. Timeout or RR failure the CCM shall indicate to RRM that the LU has failed. In the event of an LU failure, RRM shall re-attempt. The retransmit period shall be determined by timer T_LU. N_LU re-tries shall be permitted after which the aircraft shall cease Location Update/registration attempts. A new selection of GSIC or a WOW "cycle" shall initiate a new Location Registration/Update.

The cause code values (ETS 300 326-2 [2] subclause 10.11.8.5.3.6) shown in table 7 shall be used between GSC and AT to indicate the status of Location Registration/Update requests together with, where appropriate, the outgoing call barring services active for the GSM subscriber.

Table 7: CCM Cause value usage for location management

Cause Value		Cause Number	GSS Response Code	Cause	Diagnostic
765 000	4321 0010	2	S60	Successful Passenger Location Update/Registration - all outgoing calls barred	
000	0100	4	S61	Successful Passenger Location Update/Registration - all outgoing international calls barred	
000	0101	5	S62	Successful Passenger Location Update/Registration - all outgoing international calls barred except to home PLMN country	Home country code included as a string of IA5 characters
000	1101	13	S63	Successful Aircraft Location Update	
000	1110	14	S64	Successful Aircraft/Passenger Deregistration	
000	1111	15	S65	Successful Passenger Location Update/Registration - no calls barred	
010	1001	41	S68	Aircraft/Passenger Location Update/Registration/Deregistration failure - temporary failure	
100	0101	69	S69	Aircraft/Passenger Location Update/Registration/Deregistration failure - permanent failure	

The AT shall perform periodic Location Updating. A further Location Update shall be attempted T_PLU following a successful Location Update.

5.2.2.2 Location de-registration

When the AT approaches the limit of the current selected GS and there are no surrounding GS available which satisfy the handover criteria, the AT shall initiate Location Deregistration. The procedure shall follow that defined in subclause 5.2.2.1.

5.2.2.3 TFTS ground to air availability notification

In the event of a failed Location Update, an ECL message shall be initiated by the AT and passed to the CCS. This message is a modified **TFTS Available** message (ARINC 746 attachment 11). The ECL message is organized so that there are three message types: EVENT REPORT, GET and SET. A new TFTS Ground to Air Availability Message is proposed with an attribute 54H. The new attribute will have the same characteristics as **TFTS Available**. See annex A.

5.2.3 Passenger registration message handling

A **Passenger Registration** or **De-Registration** message shall be received from the CCS as a normal call control SETUP message. On receipt, the CCM entity shall request the establishment of radio resources as ETS 300 326-2 [2] subclause 10.11.4.2. When the indicated radio resources are established CCM shall forward the SETUP (Passenger Registration or Passenger De-Registration) message to the GSS, as a normal call SETUP. The handling of the CALL PROCEEDING, DISCONNECT messages and subsequent release of radio resources shall be as per ETS 300 326 subclause 10.11.4. A successful registration/de-registration shall be determined by the CCS, based on a successful release cause value from the GSS (see table 5).

5.2.4 Incoming call page handling

The AT shall monitor all GS on the scanning receiver such that the current selected GS is scanned alternately with each of the other GS in the current list:

- Current_GS;
- GS1;
- Current_GS;
- GS2;
- Current_GS;
- GS3 ... etc.

This shall ensure the AT is capable of receiving a SYSTEM INFORMATION 6 (ETS 300 326-2 [2]) PAGE request message on the BCCH(D) channel for 6 seconds in every 12 seconds.

When the AT receives a PAGE request for an incoming call, it shall delay any decision on selection of a new GS (LU) until the page transaction has been completed and the page channel released. This requires the AT to defer handover or cell re-selection for a period T_{HO}. The AT is not required to delay the cell selection before initiating the call set-up for the air to ground portion of the call. The routing number provided in the CALL ALERT PAGE message will be used to route the call to the correct GSC.

The processing of a PAGE request shall be as defined in ETS 300 326-2 [2] subclause 10.11.3.3.

If a PAGE request for an incoming call is received from a GS which is not the current GS, the PAGE request shall be ignored.

A PAGE channel is established between the GSS and the CCS. Received PAGE data is transferred by the AT to CCS, (reference ARINC 746 attachment 11).

The AT shall interpret the call alert page data message (table 3) and convert the credit card format from ETS 300 326 subclause 10.11.8.5.3.7.2 to format ARINC 746 attachment 11 subclause 4.2.5.1.

5.3 Ground station system

5.3.1 General

The functionality carried out by the GSS includes:

- a) receive passenger registration and location update SETUP messages from the AS;
- b) generate passenger registration and location update messages and forward to GLR;
- c) page AS and transfer incoming call alert page data from GLR to AS;
- d) generate ground to air call routing number and insert in page data;
- e) connect incoming call from GSM and air to ground call from AS on current GSC or from another GSC;
- f) handle conditional call diverts, in conjunction with GLR;
- g) handle transfer of SMS messages to aircraft;
- h) manage call record generation.

5.3.2 GSS architecture

Physical requirements for GSS to GLR communications are not prescribed by the present document and therefore any suitable data transmission media and protocols may be utilized in the implementation. Information on data networking requirements is therefore only provided for information. The present document does however specify the information content and format of all data messages.

An overview of TFTS GSS architecture is shown in figure 4.

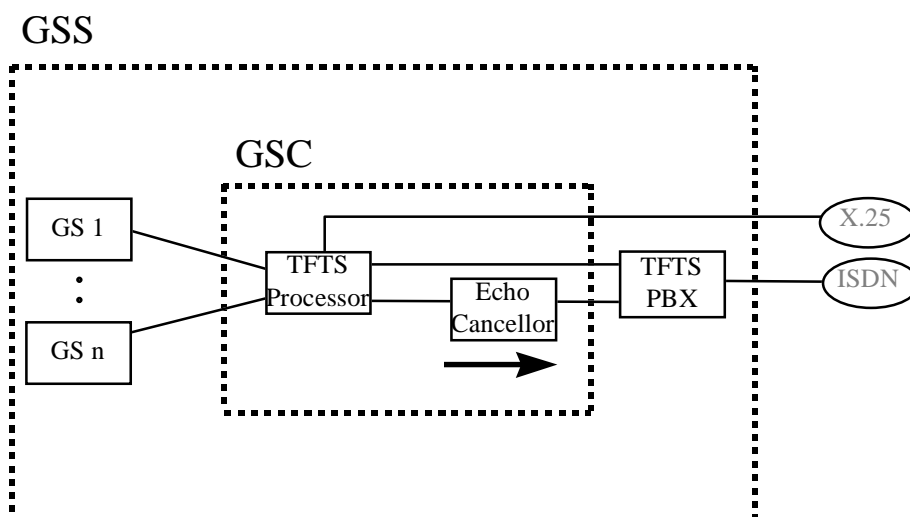


Figure 4: GSS architecture

5.3.3 GSS to GLR communications

Physical requirements for GSS to GLR communications are not prescribed by this Technical Specification and therefore any suitable data transmission media and protocols may be utilized in the implementation. Information on data networking requirements is therefore only provided for information. The present document does however specify the information content and format of all data messages.

5.3.3.1 Message routing options and link management - X.25 networks

Where X.25 public data networks are used to provide data transmission between GSC and GLR, it is possible to provide different networking configuration, to gain efficiencies in data transmission costs.

A point to point connection is used where a single Telecom Operator's GSC has to be connected internationally to the GLRs. An intermediate GLR or message router could be used where a Telecom Operator has multiple GSCs. This Intermediate Location Register (ILR) is used as a gateway and is transparent on the messages routed between the GSCs and the GLRs.

5.3.3.1.1 Link management - GSS to GLR

A dedicated virtual circuit is used for messages sent from GSC to the GLR. Virtual circuits can be established to more than one GLR where necessary. This is an "on-demand" access, that is to say, if the link is not opened, the GSC opens it, and keeps it opened until a timer expires (Timer is restarted each time there is a new transaction on that virtual circuit). If the timer parameter is set to 0, that means it is a permanent circuit (i.e.: the GSC does not clear it by itself).

Call setup

The X.25 call setup is sent to the corresponding Service Provider's GLR. The call packet user data field contains 16 digits with:

- byte 1: 8 ascii (38H);
- byte 2 to 16: space (or SP).

5.3.3.1.2 Link management - GLR to GSS

A dedicated incoming access is reserved at the GSC side, on a per GLR basis. It is opened on request from each GLR.

It is not the role of the GSC to clear this link when no more transactions are needed.

Call setup

The X.25 call setup is sent by the corresponding service provider's GLR. The call packet user data field contains 16 digits with:

- byte 1: 9 ascii (39H);
- byte 2 to 16, access control: 9 bytes for login;
- 6 bytes for password.

5.3.4 Registration and location management

The GSS receives both passenger registration/de-registration and AS LU messages from the AS as call control SETUP messages (subclause 5.1.2.1).

The information contained in these messages is formatted into a common Registration/LU Request message and forwarded to the GLR. No record of registered AS or passengers is retained by the GSS, as there may be no positive de-registration or notification of change of location.

In the event of a failed passenger registration, a Passenger Registration Request Response message is returned from the GLR. The GSS then disconnects the registration SETUP call from the AS, with a failure cause. This information shall enable the CCS to display information to the passenger to indicate that the registration has failed.

The format and content of the Registration/LU messages is shown in table 8.

Table 8: Registration/LU Messages

Element No.	Element	Format	Comment
	Message ID	n4	Request: 0320 Repeat: 0321
	Bit Map	b64	22 20 00 00 20 A0 00 02
3	Processing Code	n6	VCR Reference
7	Transmission Date & time	n10	
11	System Audit Trace No.	n6	
35	Track Two Data	LL-CC	
41	Card Acceptor Terminal ID	n9	
43	No.Destination Telephone Number	n18	Location Registration Services (table 2)
63	User Data	LLL-UD	"013"
		3 hex	GSIC
		3 ascii	SPID
		4 hex	Handset ID

If the handset ID field is not used, this shall be filled with spaces.

Each Registration/LU Request Message is initiated by the GSS. The GLR responds with a Registration/LU Response message. The transmission time and date field should always be generated by the network element which is the source of the message.

The format of the Response message is shown in table 9.

Table 9: Registration/LU response message

Element No.	Element	Format	Comment
	Message ID	n4	Response: 0330
	Bit Map	b64	22 20 00 00 02 80 00 02
3	Processing Code	n6	VCR Reference
7	Transmission Date &time	n10	
11	System Audit Trace No.	n6	
39	Response code	n3	Table 7 - GSS - GLR Cause
41	Card Acceptor Terminal	n9	
63	User Data	LLL-UD	"009"
		3 hex	GSIC
		3 ascii	SPID

5.3.5 Incoming call page message handling

5.3.5.1 Receipt of incoming call alert

When a mobile terminating call is received by the GSM user's HLR, routing information is requested from the GLR and subsequently from the GSS. The message from the GLR to the GSM performs the following:

- alerts the GSS of the incoming call;
- provides the GSS with details of target AS, passenger and handset;
- requests from the GSS routing information.

A Call Alert Page Request message is received from the GLR. The format of this message is shown in table 10. This information shall formatted in a page message to the AS in the format specified in table 3. The Routing Number is generated by the GSC and inserted in the Routing Number field.

Table 10: Call alert page request format

Element No.	Element	Format	Comment
	Message ID	n4	Request: 0340 Repeat:0341
	Bit Map	b64	02 20 00 00 20 84 00 16
7	Transmission Date&time	n10	
11	System Audit Trace No.	n6	
35	Track Two Data	LL-CC	ETS 300 326 subclause 10.11.8.5.3.7.2
41	Card Acceptor Terminal ID	n9	ASI + AEN
46	Reference	n5	00000 up to 49999
60	Addressing Mode	n1	0
62	Broadcast Duration	n5	00001 up to 32767
63	User Data	LLL-UD	
		3 hex	GSIC
		3 ascii	SPID
		4 hex	Handset ID
		n1	Service Discriminator 0 = speech call 1 = SMS message all other values reserved
		n1	Length of text
		0-120	Text GSM reference - table 3
		n1	Length of text
		0-160	GSM SMS User Data field

Once a page channel has been established with the AS, the GSS provides routing information to the GLR, in a Call Alert Page Response message (table 11). This message is interpreted by the GLR as a Send Routing Number message.

Table 11: Call alert page response

Element No.	Element	Format	Comment
	Message ID	n4	Response :0350
	Bit Map	b64	02 20 00 00 02 24 00 02
7	Transmission Date&time	n10	
11	System Audit Trace No.	n6	
39	Response Code	n3	
43	Destination Telephone No	n18	DDI routing No at GSC
46	Reference	n5	same as Request message (table 10)
63	User Data	LLL-UD	"009"
		3 hex	GSIC
		3 ascii	SPID

The page message is specified in ETS 300 326-2 [2] subclause 10.11.5.2.2.

5.3.5.2 Mechanism to page AS

In order to efficiently use radio resources and optimize the page delivery time, an algorithm is required in the GSS to deliver page requests on a regular pattern. See subclause 5.2.4.

This algorithm is not defined within the scope of the present document. However, the design objective of the algorithm is to maximize the traffic carrying capacity of the system, by broadcasting page information in a timely manner that supports optimal capacity.

5.3.6 Call connection

The GSS provides a routing number to the GLR, which is an DDI number on the GSS PBX. This call is received by the GSC which responds to GSM with an ALERTING message and in-band ringing tone.

When the passenger accepts the incoming call, a call is established by the CCS in the normal manner, from air to ground. The routing of this call is to a GSS initiated number, which can be recognized and connected to the incoming call.

Once the incoming call SET-UP message has been received from the PSTN, the GSS initiates a PAGE RELEASE REQUEST message as in table 12. On receipt of this message, the GLR returns a PAGE REQUEST CONFIRM message. The GLR will close the SVC if no transactions are in process.

Table 12: Page release request and confirm

Element No.	Element	Format	Comment
	Message ID	n4	Request: 0380 Confirm: 0390
	Bit Map	b64	2220 0000 0204 0002
3	Processing Code		
7	Transmission Date&time	n10	
11	System Audit Trace No.	n6	
39	Response Code	n3	Request: S60 - Call control accepted S68 - Call control rejected Confirm: = 3 spaces
46	Reference	n5	Request: 00000 up to 49999 Confirm: same as request
63	User Data	LLL-UD	"009"
		3 hex	GSIC
		3 ascii	SPID

The response code is returned by the GSC. A timer T_AGS is initiated on initiation of the page to the aircraft. On expiration of this timer determines no reply to ground to air call.

5.3.7 Call forwarding

In the event that the call cannot be completed, due to a TFTS state listed in table 13, the GSS shall hold the incoming call and requests call forwarding information from the GLR. This shall be achieved by sending a Get New Number message formatted according table 14.

Table 13: TFTS to GSM Call state translation

TFTS STATE	GSM STATE	CONDITION
Handset busy	BUSY	CFB
Incoming call rejected by passenger	BUSY	CFB
No answer from passenger	NO REPLY	CFNRy
No response to page (page channel not established)	NOT REACHABLE	CFNRc
Page transaction incomplete (data transfer)	NOT REACHABLE	CFNRc
No resource available (radio or GSS)	NOT REACHABLE	CFNRc

Table 14: Get new number

Element No.	Element	Format	Comment
	Message ID	n4	Request :0360 Request Repeat:0361
	Bit Map	b64	22 20 00 00 00 04 00 02
3	Processing Code	n6	
7	Transmission Date&time	n10	
11	System Audit Trace No.	n6	
46	Reference	n5	00000 up to 49999
63	User Data	LLL-UD	"010"
		3 hex	GSIC
		3 ascii	SPID
		n1	Reject Cause 1 Not reachable 2 No answer 3 Busy

A response to the Get New Number message shall be returned by the GLR in the format detailed in table 15.

Table 15: Get new number response

Element No.	Element	Format	Comment
	Message ID	n4	Response :0370
	Bit Map	b64	22 20 00 00 00 24 00 00
3	Processing Code	n6	
7	Transmission Date&time	n10	
11	System Audit Trace No.	n6	
43	Destination Number for Divert	n18	E.164 [11]
46	Reference	n5	same as Request message (table 14)
63	User data	LLL-UD	"009"
		3 hex	GSIC
		3 ascii	SPID

If the GSM user has no configured divert numbers, the GET NEW NUMBER RESPONSE message will be returned with an empty destination number field. In this case, the call handling should be completed by the GSS by providing appropriate in-band signalling information (tones or message). This call should be terminated as not chargeable.

5.3.8 Administration

The GSS creates administration records for each registration/LU message. System reference numbers are included in all GSS initiated messages.

5.4 Gateway location register

5.4.1 General

The Gateway Location Register (GLR) provides an interface between TFTS and GSM networks and carries out the following primary functions:

- a) Location Management;
- b) Registration Management;
- c) GSM Visited Location Register;
- d) Call Handling;
- e) Signalling and Message Translation;
- f) Data management;
- g) GSM Visited MSC functionality for Mobile Terminated SMS.

5.4.2 Location management

The GLR stores a register of aircraft permitted to receive calls from GSM. Each aircraft provides a LU to the GLR when it changes GS/GSC. The register of aircraft stores the current GS/GSC for each aircraft, to enable ground to air calls to be delivered to the correct GS/GSC.

Messaging required to establish an AS location register is between GSS and GLR only. The message is initiated as a SETUP message by the CTU, and a message is created by the GSS and passed to the GLR. This message is carried on an X.25 network connection, which is established either as a switched or permanent virtual circuit. The X.25 session includes a login and password for authentication.

5.4.3 Registration management

5.4.3.1 Registration

Passenger registration messages are sent from the CCS to the GLR, as a SETUP message to the GSS and then as a GSS generated message to the GLR. The message is carried on an X.25 network connection from the GSS to the GLR which is established either as a switched or permanent virtual circuit. The X.25 session includes a login and password for authentication. A passenger registration message is required for each passenger registering to receive calls. Passenger de-registration messages are transmitted in the same manner.

The information provided in the registration message shall identify the passenger within the GLR database and to identify the MSISDN of the passenger. However, to register the user on the GSM HLR, the MSISDN shall be converted to IMSI. This operation is carried out by requesting SRI from the GSM HLR and requires that the user has SMS provisioned.

The GLR accepts the registration, converts the information as required, communicates with the GSM HLR, updates the GLR database (with information from the GSS and GSM HLR) and responds to the GSS. If the registration is unsuccessful, the GLR responds to the GSS with a Passenger Registration Request Response message indicating failure.

The GLR stores a register of all GSM users who have pre-registered to roam on the TFTS system. The passenger registration is carried out before a flight. The register stores the GSM users' MSISDN number, an associated magnetic stripe card number which would be used to invoke registration, an optional text message to be displayed with the incoming call and the registration status. The status of each GSM user's registration is maintained by registration/de-registration messages forwarded from the GSS.

The GLR shall accept the registration, convert the information as required, communicate with the GSM HLR, update its own database (with information from the GSS and GSM HLR) and respond to the GSS, indicating not only the whether the registration has been successful but also the call barring services applicable to the GSM subscriber. The latter shall be communicated to the GLR using the GSS Response Codes detailed in table 6.

5.4.3.2 De-registration

Passengers who have registered to receive calls can be de-registered from TFTS in a number of ways:

- a) All passengers registered on an aircraft are de-registered once X% of the registered passengers have de-registered, by registering on a GSM network (switching on GSM handset). This global de-registration would only occur after a period T1 minutes after the first passenger registration;
- b) All passengers on an aircraft would be **de-attached** if a positive LU is not received from an aircraft for a period of T2 minutes;
- c) All passengers on an aircraft would be **de-registered** if a positive LU is not received from an aircraft for a period of T3 minutes;
- d) All passengers on an aircraft would be de-registered if an AS LU de-registration message is received. This message is initiated by the AS when the AS does not detect any GS other than the current GS and it is approaching the LIM of the current GS. The message should be initiated by the AS approximately T4 minutes before the AS is estimated to reach LIM, estimated based on current speed and course;
- e) If implemented, CTU register of passengers would be deleted T5 minutes after the aircraft has landed WOW (independent of TFTS coverage);
- f) A passenger may manually elect to de-register from TFTS by selecting an option on the telephone handset. This invokes a passenger de-registration message to be sent to the GLR.

Table 16: De-registration parameters

Parameter	Default Value
Proportion X% of passengers to de-register from a single aircraft	50%
T1	5 min
T2	30 min
T3	60 min
T4	2 min
T5	10 min

5.4.4 Call handling

5.4.4.1 Incoming call

When an incoming call request is received by the home network, the HLR requests call routing information from the GLR, which shall be registered and function as the associated VLR for the mobile subscriber. The GLR shall in turn request routing information from the GSS. This is carried out by a Call Alert Page Request message, initiated from the GLR. The Call Alert Page Request alerts the GSS of the incoming call, provides call routing information including AS, passenger and handset identifier and requests call routing information. The target GSS shall be the current GSS for the AS from which the subscriber registered. The GSS returns the routing number at the GSC, which the GLR shall forward to the GSM HLR.

The GLR shall format the Call Alert Page Request message in the format specified in table 10.

When the incoming call is received at the GSS, a PAGE REQUEST RELEASE message is sent to the GLR. On receipt, the GLR closes the SVC.

5.4.4.2 Call forwarding

GSM call conditions **Call Forwarding Unconditional (CFU)** and **Call Forwarding Not Reachable (CFNRc)** are generally handled by the HLR. However, in the case of delivering a call to an aircraft, it is possible that the subscriber shall become **not reachable** during the time that the call control is being handed over to the GSS. The GSS should therefore process the call as a GSM VLR. Call forwarding information is not provided to the GSS but is retained in the GLR (received during location update to HLR). If the GSS is required to carry out call forwarding, the GSS shall request the call forward routing information from the GLR. The TFTS states which may require call forwarding and the associated GSM call states are shown in table 11.

5.4.5 Signalling and message translation

The GLR carries out communication management of both X.25, for the GSS to GLR interface, and MAP communications for the GLR to HLR interface and SMS GMSC to GLR interface.

In most cases, the GLR carries out message translation between GSS and HLR/SMS GMSC originated messages. The translation may be required on each individual message (e.g. passenger registration) or in response to a single message (e.g. aircraft de-registration).

The GLR shall also handle other GSM initiated messages. A list of GSM HLR originated messages and the action to be taken by the GLR is detailed in table 17.

Table 17: Handling of GSM HLR originated messages

HLR message	Action taken by GLR
Cancel Location	This message means that the mobile subscriber has registered back in GSM. The GLR should perform location de-registration. If the proportion of subscribers registered on the same aircraft exceeds the parameter listed in table 11, then the GLR should de-register the location for all subscribers from the same aircraft, after time T3.
Insert Subscriber Data	If subscriber data is updated by the HLR, this shall be forwarded to the GLR and accepted in the GLR database.
Delete Subscriber Data	If subscriber data is deleted by the HLR, a message shall be forwarded to the GLR and deleted from the GLR database.
Reset	A message shall be forwarded to the GLR in the event of a failure with the HLR. This should be ignored by the GLR.
Restore	If a message is received from the HLR for an unidentified subscriber, the GLR responds with a Restore MAP message.
Forward Check SS Indication	This message shall be ignored by the GLR.
Active Trace Mode	This message shall be ignored by the GLR.
De activate Trace Mode	This message shall be ignored by the GLR.

5.4.6 Data management

In addition to the standard VLR profile information required to allow subscribers to inter-work between the two systems, the minimum subscriber data required is detailed in table 18.

Table 18: GLR data elements

Information source	Information element	Status of data
GSS	GSIC (GCC+GSN)	Static
	X.25 Network User Address	Static
	Registered Flag	Static
Aircraft	ATEI (ASI+AEN)	Static
	GSIC (GCC+GSN)	Dynamic
	Registered Flag	Dynamic
Passenger	CC Value	Static
	ATEI Code	Dynamic
	IMSI	Dynamic
	MSISDN	Static
	PIN	Static
	Services Registered	Dynamic (initially should be able to register SMS, speech or both, but extensions to support fax and data may be required)
	CFB Number	Static/dynamic
	CFNRy Number	Static/dynamic
	CFNRc Number	Static/dynamic
	Registered Flag	Dynamic

The status of data elements indicates that static elements are those controlled by operation and administration and dynamic elements are those which are controlled and modified by the network. Static data is provisioned once and maintained on an ongoing basis. Dynamic data is continually updated from the network.

5.4.7 SMS handling

The GLR shall act as a GSM Visited MSC (VMSC) for the purposes of delivering SMS messages to passengers who have registered to receive their SMS messages on board aircraft. The complete SMS User Data field (i.e. the content of the TCAP messages) shall be delivered across the network to the CCS using the same mechanism as for ground-to-air speech calls (see subclause 5.4.4).

6 Information flows

For all of the following call flows, dashed lines have been used to highlight commands which may not be required due to a specific implementation. Particularly, these relate to previously established X.25 connections.

6.1 Aircraft system location registration/de-registration

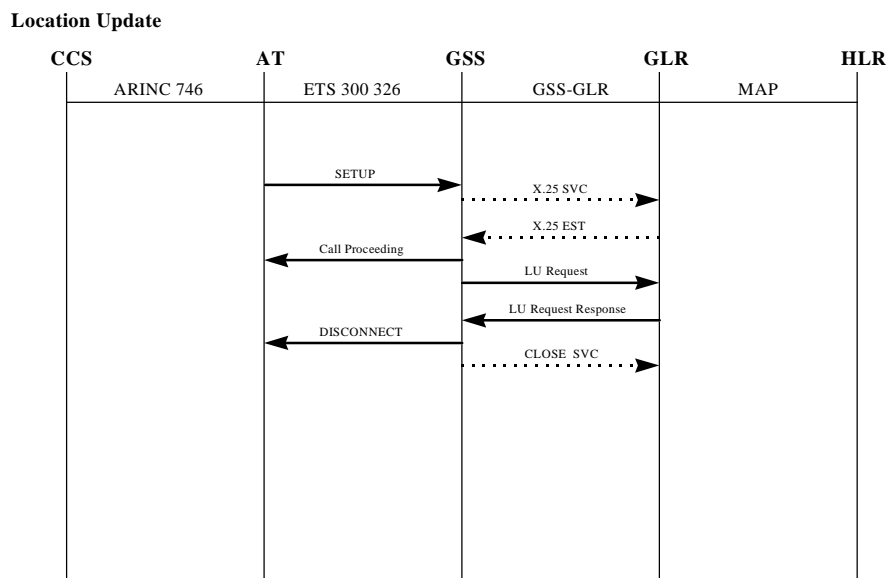


Figure 5: Location update call flow

6.2 Passenger registration/de-registration

Passenger Registration/De-registration

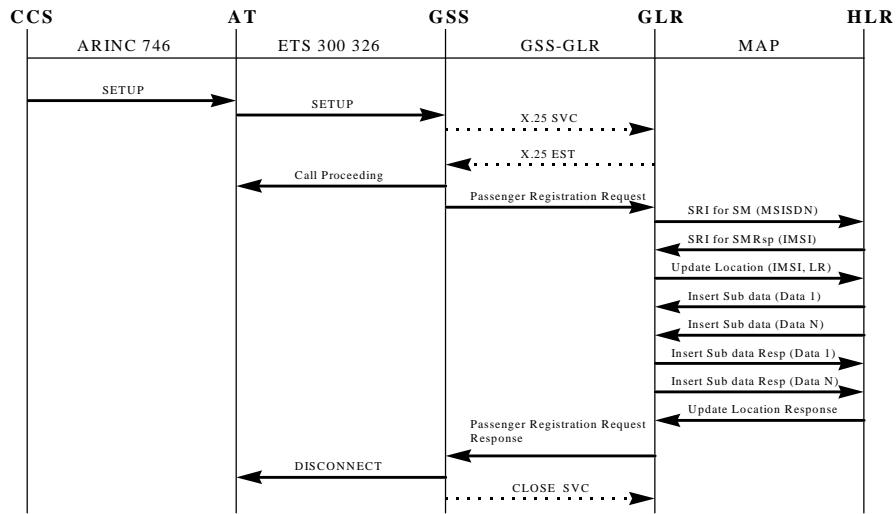


Figure 6: Passenger registration/de-registration - call flow

6.3 Call delivery

Call Delivery

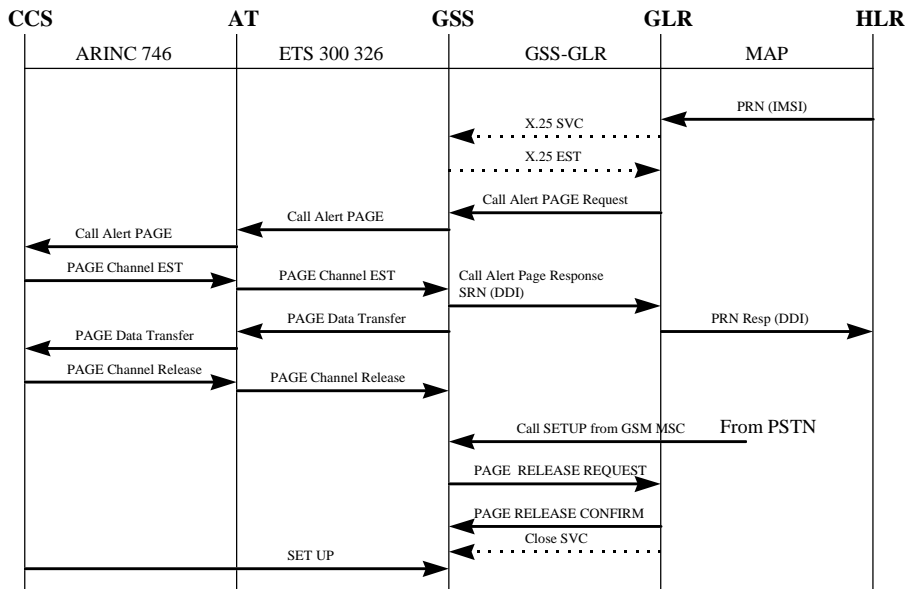


Figure 7: Call delivery - call flow

6.4 Call forwarding

Call Forwarding

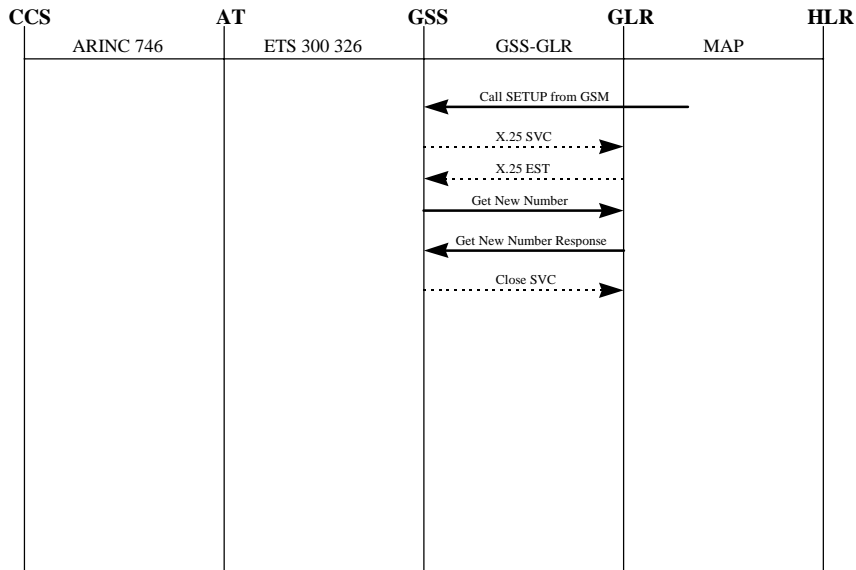


Figure 8: Call forwarding - Call flow

6.5 Ground-to-air SMS

SMS ground-to-air

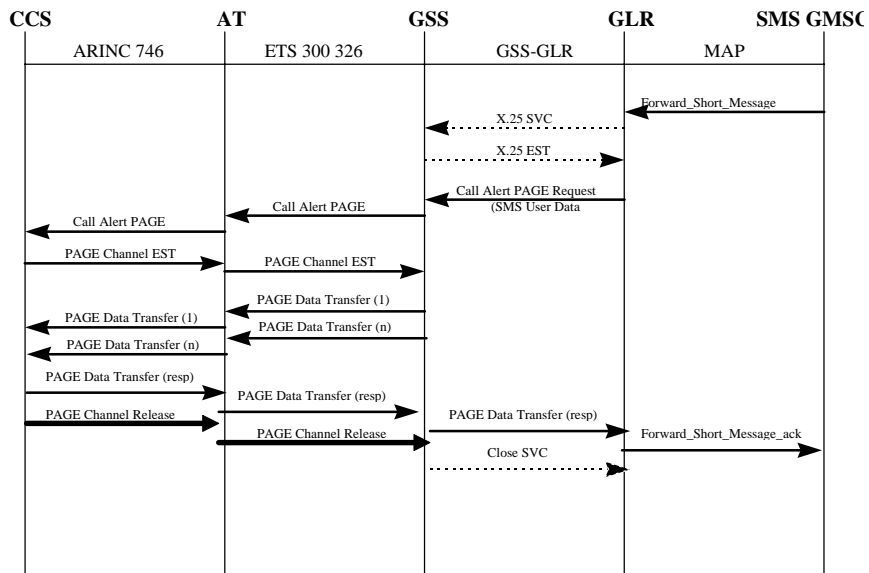


Figure 9: Ground-to-air SMS

7 Timers and counters

7.1 Timers

T_HO Default 15 s

T_PW Default 20 s

T_LU Default 60 s

T_PLU Default 1800 s (30 minutes)

T_AGS Default 30 s

7.2 Counters

N_LU Default 2

Annex A (informative): Modified ARINC 746 ECL messages

A.1 TFTS availability

The TFTS status should be indicated to the CTU through the use of an information element within an Event Report message or, in response to a Get message. The Information element can provide one or more of a number of attributes. Two attribute identifiers are relevant to TFTS. One attribute identifier is defined in ARINC 746 attachment 11; another is defined here. The coding of the attribute values should be as defined in the tables below.

Table A.1

TFTS Availability information element									
OCTET	BITS								DESCRIPTION
	8	7	6	5	4	3	2	1	
1	0	0	0	1	0	1	0	1	Attribute List Identifier
2									Attribute Identifier
3									Attribute length
4									Attribute value
.									.
N									Attribute Identifier
N+1									Attribute length
N+2									Attribute value
.									.

Table A.2

Information Element Attribute Identifier Coding									
		BITS							
		8	7	6	5	4	3	2	1
TFTS Availability	51H	0	1	0	1	0	0	0	1
TFTS Ground to Air Availability	54H	0	1	0	1	0	1	0	0

Table A.3

TFTS Ground to Air Availability Information Element Attribute Values											
ATTRIBUTE STATE				VALUE							
				BITS							
				8	7	6	5	4	3	2	1
Ground to Air Service not available				0	0	0	0	0	0	0	0
Ground to Air Service available				0	0	0	0	0	0	0	1
Ground to Air Service not available due to shutdown				0	0	0	0	1	0	0	0

History

Document history		
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