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Digital Audio Broadcasting (DAB); Network Independent Protocols for Interactive Services

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Reference

DES/JTC-DAB-15

Keywords

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Content

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Foreword

This ETSI Standard (ES) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI)(Broadcast).

NOTE 1: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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The Eureka Project 147 was established in 1987, with funding from the European Commission, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers. Their work resulted in the publication of European Standard, ETS 300 401 [2], for DAB (see note) which now has worldwide acceptance. The members of the Eureka Project 147 are drawn from broadcasting organizations and telecommunication providers together with companies from the professional and consumer electronics industry.

NOTE 2: DAB is a registered trademark owned by one of the Eureka Project 147 partners.

1 Scope

The present document covers the core Digital Audio Broadcasting (DAB) requirements to enable interactive services supporting broadcasting to mobile, portable and fixed receivers with narrowband return channels.

The system defined in the present document provides a variety of generic solutions for a variety of future interactive services, through the adoption of the MOT protocol (specific for DAB) and the IP protocol.

The interactive services are provided on systems consisting of a high bitrate downstream channel (up to the maximum bitrate of the broadcast channel) from the service providers to service consumers and low bitrate interaction channels. The Broadcast service provider and the interactive service provider need not operate from the same location (see figure 2).

The services are seen from DAB Program Associated Data (PAD) enhanced and standalone (packet mode) data broadcasting services with interactivity. At the simplest level the interactive channel allows the consumer to react by voting, to order articles displayed in the broadcast or make reservations of hotel rooms, restaurant tables, etc. It is also possible to deliver text, graphics, audio and still pictures (including e-mail) on-demand, both via the broadcast channel and the interaction channel.

There are many possible network configurations covering the currently specified DAB broadcast options including terrestrial, satellite and cable in conjunction with GSM, PSTN, ISDN, DECT and other interactive channel options. The specification of the network dependent protocols are specified within TS 101 737 [3].

In the process of producing the present document the specifications for an interaction channel for Digital Video Broadcasting (DVB) has carefully been studied. The goal has been to as far as possible be compatible with the DVB solutions thereby creating a common concept of treating the combination broadcast-/telecommunicationsystem. Although the use of existing DAB data transfer protocols for the broadcast channel, when appropriate, has been essential in the writing 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, the latest version applies.

[1] ETSI EN 301 234: "Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol".

[2] ETSI ETS 300 401: "Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[3] ETSI TS 101 737: "Digital Audio Broadcasting (DAB); Interaction channel through Global System for Mobile communications (GSM) the Public switched Telecommunications System (PSTN); Integrated Services Digital Network (ISDN) and Digital Enhanced Cordless Telecommunications (DECT)".

[4] ETSI TS 101 756: "Digital Audio Broadcasting (DAB); Registered Tables".

[5] ETSI TS 101 735: "Digital Audio Broadcasting (DAB); Internet Protocol (IP) datagram tunnelling".

[6] IETF/RFC 768 (1980): "User Datagram Protocol", J. Postel.

[7] IETF/RFC 791 (1981): "Internet Protocol (IP)", J. Postel.

[8] IETF/RFC 793 (1981): "Transmission Control Protocol", J. Postel.

[9] IETF/RFC 1332 (1992): "The PPP Internet Protocol Control Protocol (IPCP)", G. McGregor.

[10] IETF/RFC 1661 (1994): "The Point-to-Point Protocol (PPP)", W. Simpson.

[11] ISO/IEC 8859-1 (1998): "Information technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No. 1".

[12] IETF/RFC 959 (1985): "File Transfer Protocol (FTP)", J. Postel, J.K. Reynolds.

[13] IETF/RFC 1700 (1994): "Assigned Numbers", J. Reynolds, J. Postel.

[14] IETF/RFC 1725 (1994): "Post Office Protocol - Version 3", J. Myers, M. Rose.

[15] IETF/RFC 1994 (1996): "PPP Challenge Handshake Authentication Protocol (CHAP)", W. Simpson.

[16] IETF/RFC 2068 (1997): "Hyper Text Transfer Protocol - HTTP/1.1", R. fielding, J. Gettys, J. Mogul, H. Frystyk, T. Berners-Lee.

[17] GSM 03.40: "Digital cellular telecommunications system (Phase 2+); Technical realization of the Short Message Service (SMS) Point-to-Point (PP)".

[18] GSM 03.38: "Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information".

3 Abbreviations

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

BC	Broadcast Channel
CHAP	Challenge Handshake Authentication Protocol
DAB	Digital Audio Broadcasting
DAB-RM	Digital Audio Broadcasting - Receiver Module
DECT	Digital Enhanced Cordless Telecommunications
DVB	Digital Video Broadcasting
EId	Ensemble Identifier
EUA	End User Address
FBC	Feed Back Channel
FTP	File Transfer Protocol
GSM	Global System for Mobile communication
HTTP	Hyper Text Transfer Protocol
IC	Interaction Channel
IETF/RFC	Internet Engineering Task Force/Request For Comments
IM	Interaction Module
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
ISDN	Integrated Services Digital Network
LCP	Link Control Protocol
MMI	Man Machine Interface
MOT	Multimedia Object Transfer protocol
MSC	Main Service Channel
NCU	Network Control Unit
OSI	Open Systems Interconnection
PAD	Programme Associated Data
PAP	Password Authentication Protocol
POP3	Post Office Protocol
PPP	Point-to-Point Protocol
PSSC	Personal Service Session Control protocol
PSTN	Public Switched Telephone Network
SCId	Service Component Identifier

SId	Service Identifier
SMS	Short Message Service
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UT	User Terminal
X-PAD	Extended Programme Associated Data

4 Reference models

4.1 Protocol stack model

For asymmetric interactive services supporting broadcast to mobile/portable/stationary receivers with a narrowband return channel, a simple communication model consists of the following layers:

application layer: is the interactive application software and runtime environments (e.g. home shopping application, script interpreter, etc.).

transport layer: defines all the relevant data structures and communication protocols.

physical layer: where all the physical (electrical) transmission parameters are defined.

The present document addresses the lower two layers (the physical and transport) leaving the application layer open to competitive market forces. It is not the role of the present document to define standardized applications.

A simplified model of the OSI layers is adopted to facilitate the production of specifications for these nodes. Figure 1 points out the lower layers of the simplified model and identifies some of the key parameters for the lower two layers. Following the user requirements for interactive services, no attempt will be made to consider higher layers in the present document.

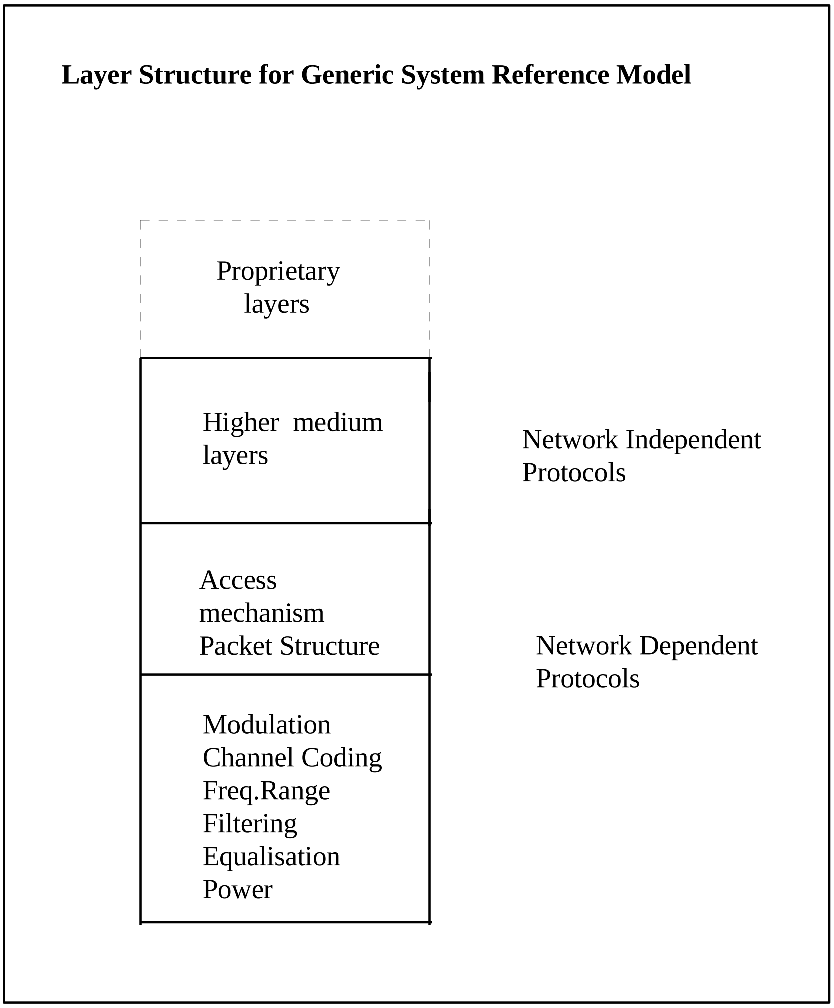


Figure 1: Layer structure for generic system reference model

4.2 System model

Figure 2 shows the system model which is to be used within DAB for interactive services.

In the system model, two channels are established between the service provider and the end user:

Broadcast Channel (BC): an unidirectional broadband broadcast channel that can include audio, low bit-rate video and different types of data. BC is established from the service provider to the end users. It may include the forward interaction path in other words distributing individually addressed data to the end user.

Interaction Channel (IC): a bi-directional interaction channel is established between the service provider and the end user for interaction purposes. It is formed by:

- **return interaction path (return channel):** from the end user to the service provider. It is used for instance to make requests to the service provider or to answer questions. In most cases it is a narrow-band channel also commonly known as return channel;

- **forward interaction path:** from the service provider to the end user. It is used to provide some sort of individually addressed information by the service provider to the end user and any other required communication for the interactive service provision. It may be embedded into the broadcast channel. It is possible that this channel is not required in some simple implementations which make use of the broadcast channel for the carriage of data to the end user.

The UT is formed by the DAB Receiver Module (DAB-RM), the Interaction Module (IM), the Man Machine Interface (MMI) and the application module. The UT provides interface for both broadcast and interaction channels. The interface between the UT and the interaction network is via the interaction module.

The interface between the broadcast channels and the user terminal is via the DAB receiver module.

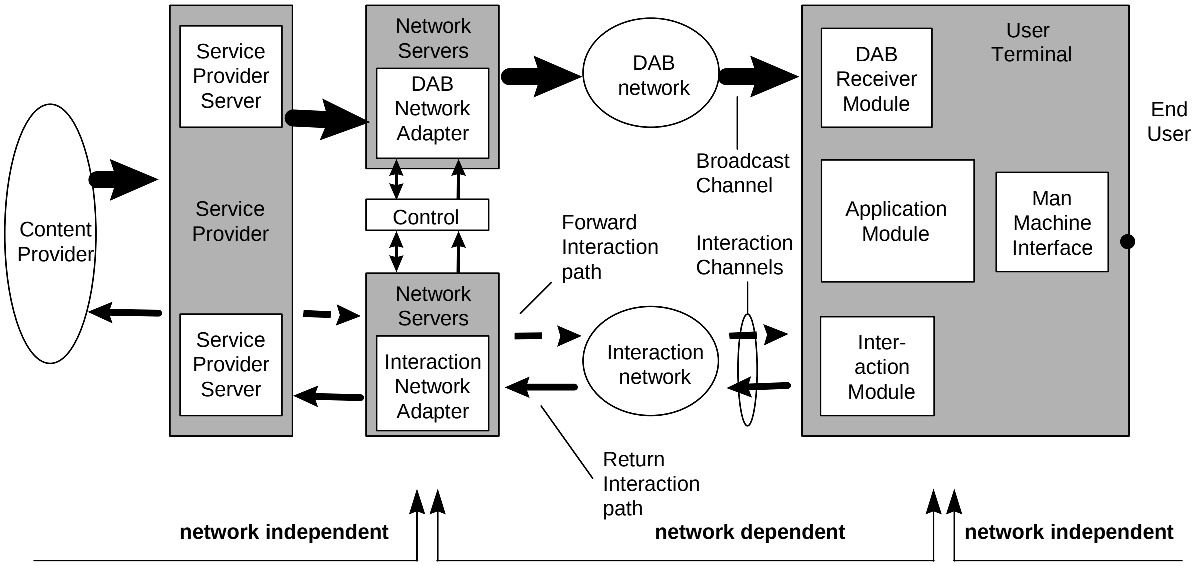


Figure 2: A generic system reference model for interactive systems based on DAB

5 Protocol stacks

5.1 General

This clause describes the different protocol stacks for the broadcast channel and the interaction channel that should be used in order to implement an interactive DAB service. Guidelines of which protocols that are suitable for specific types of interactive services are found in annex A of the present document.

5.2 Content transport - data

5.2.1 Broadcast channel

Two categories of data transport are provided/recommended for the DAB channel depending on if the DAB channel is used for broadcast or individually addressed information.

(i) DAB specified transmission system with MOT.

Table 1: Protocol stack for MOT via broadcast channel

Higher layers	
MOT	
Packet mode (MSC Data groups)	MOT (X-PAD Data groups)
Packet mode (packets)	X-PAD (data sub-fields)
DAB-MSC	

The Multimedia Object Transport (MOT) protocol as specified in EN 301 234 [1] and DAB-MSC, packet mode and X-PAD protocols as specified in ETS 300 401 [2].

(ii) DAB with UDP/IP or TCP/IP.

Table 2: Protocol stack for TCP/IP or UDP/IP via broadcast channel

Higher layers	
TCP	UDP
IP	
Packet mode (MSC data Groups)	
Packet mode (packets)	
DAB-MSC	

The mechanism for tunnelling IP datagrams within DAB is specified in TS 101 735 [5] and the DAB-MSC and Packet mode protocols are specified in ETS 300 401 [2]. The TCP is specified in IETF/RFC 793 [8], UDP in IETF/RFC 768 [6] and IP in IETF/RFC 791 [7].

In the case of the use of TCP an interaction channel is mandatory since the TCP protocol requires a flow of return acknowledgements. UDP does not use return acknowledgements and thus does not require an IC to work on the transport layer, however higher layer protocols using UDP may require an IC (return acknowledgements).

The definition of the higher layer protocols are not within the scope of the present document. However, the standard TCP/IP-family application layer protocols such as IETF/RFC 959 [12], IETF/RFC 1725 [14], IETF/RFC 2068 [16], as well as application specific proprietary protocols may be used to implement the higher layer protocols.

5.2.2 Interaction channel

Two different protocol stacks are provided for the two main different types of interaction on the IC.

(i) One-way interaction and two-way interaction (personal FBC services).

Table 3: Protocol stack for the interaction channel concerning one-way interaction and two-way interaction with personal FBC services

Higher layers		
TCP	UDP	SMS
IP		SMS
PPP	other	SMS
GSM, PSTN, ISDN, DECT	other network	GSM

(ii) Two-way interaction (personal DAB services).

Table 4: Protocol stack of the interaction channel (return path) for personal DAB services

Higher layers	
TCP	UDP
IP	
PPP	other
PSTN, ISDN, GSM, DECT	other network

The TCP is specified in IETF/RFC 793 [8], UDP in IETF/RFC 768 [6], IP in IETF/RFC 791 [7] and PPP in IETF/RFC 1661 [10].

When carrying TCP over the broadcast channel, an interaction channel shall be established for the flow of return acknowledgements. Standard TCP is adequate for delivery of content up to 150 kbit/s in secure bi-directional networks. If TCP is required to deliver data at a higher rate, work over non secure radio interfaces or on top of long delay network extensions to or special implementations of TCP are recommended. These implementations are backwards compatible with standard TCP implementations but optimize TCP to the existing situation. If this option is used the extensions of TCP shall be according to IETF/RFC 1332 [9].

Information about how the GSM Short Message Service (SMS) is used are give in GSM 03.38 [18] and GSM 03.40 [17].

The definition of the higher layer protocols are not within the scope of the present document. However, the standard TCP/IP-family application layer protocols such IETF/RFC 959 [12], IETF/RFC 1725 [14], IETF/RFC 2068 [16]..., as well as application specific proprietary protocols may be used to implement the higher layer protocols.

The specification of the network dependent protocols are specified within TS 101 737 [3].

5.3 Session control signalling

5.3.1 One-way interaction

The co-ordination of the data flow between the DAB channel and the interaction channel is subject for higher layer protocols and therefore not defined in the present document.

5.3.2 Two-way interaction with personal FBC services

The co-ordination of the data flow between the DAB channel and the interaction channel is subject for higher layer protocols and therefore not defined in the present document.

5.3.3 Two-way interaction with personal DAB services

In order to be able to establish a two-way interaction with a personal DAB service session it is necessary to do session control signalling to co-ordinate the data flow between the broadcast channel and the interaction channel. All session control signalling is done within the interaction channel and is bi-directional. The use of session control signalling is specified in clause 8 of the present document.

The session control signalling is made by sending PSSC messages in TCP or UDP over the interaction channel between the UT and the Network Control Unit (NCU). The PSSC message format is specified in clause 9 of the present document. On the NCU TCP or UDP port number 645 shall be used for session control signalling.

Table 5: Protocol stack for session control signalling for two-way interaction with forward interaction path within the broadcast channel

<table>
<tr><th colspan="2">PSSC</th></tr>
<tr><th>TCP</th><th>UDP</th></tr>
<tr><th colspan="2">IP</th></tr>
<tr><th>PPP</th><th>other</th></tr>
<tr><td>PSTN, ISDN, GSM, DECT</td><td>other network</td></tr>
</table>

The TCP is specified in IETF/RFC 793 [8], UDP in IETF/RFC 768 [6], IP in IETF/RFC 791 [7] and PPP in IETF/RFC 1661 [10].

The specification of the network dependent protocols are specified within TS 101 737 [3].

5.4 Connection control signalling

Network dependent so not defined in the present document. The specification of the network dependent protocols are specified within TS 101 737 [3].

6 PPP data link set-up

6.1 General

After the user terminal has been connected through the interaction network to the network server, the PPP configuration process is initiated. This configuration process consists of the following phases:

1) Link Control Protocol (LCP, see IETF/RFC 1661 [10]) is used to establish the data link connection;

2) IPCP (IETF/RFC 1332 [9]) is used to configure IP and the type of compression.

In phase 1) and 2), both "configure-request" and "configure-ack" packets are sent and received. In phase 2), the user terminal sends a configure-request packet that includes the IP address configuration fields at the beginning. In this case, PPP facilitates the transfer of an IP address from the interactive service provider during the initialization phase of PPP.

Authentication of the UT shall be done during data link set-up. The authentication can be done using the Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP), both as specified in IETF/RFC 1994 [15]. It also exists other authentication protocols that may be used.

6.2 PPP configuration for IP transmission

For compression of the IP address and control fields (see IETF/RFC 1332 [9]), the following protocols shall be supported in the PPP data link layer:

002l internet protocol;

002d Van Jacobson compressed TCP/IP;

002f Van Jacobson uncompressed TCP/IP.

For the PPP link, the following configuration shall be supported as recommended for PSTN type links (see IETF/RFC 1332 [9]):

- async control character map;
- magic number;
- address and control field compression;
- protocol field compression.

7 TCP connection set-up

When TCP is used as transport layer protocol the TCP connection shall be established as specified in IETF/RFC 793 [8].

The port numbers to use should specified in the higher layer protocol. See also IETF/RFC 1700 [13] for information of assigned port numbers.

8 Session control in personal DAB services

8.1 General

Session control is needed for personal DAB services to co-ordinate the data flow between the broadcast channel and the interaction channel. The personal DAB service session control signalling is done between the user terminal and the network control unit. Only one PSSC session is allowed for each UT. All session control signalling is done within the interaction channel and is bi-directional. If the session control protocol is used, the protocol stack shall be as defined in clause 5.3.3 of the present document.

All session control signalling is done with PSSC messages which are described in clause 9. The signal flow of the PSSC messages is described in clausess 8.2 to 8.5.

In parallel to the PSSC session there will be one or more sessions between the client applications in the UT and the server applications in the service provider servers. These UT to service provider application sessions are the ones that are involved with the user interaction and data transfer in the service. The relationship between the PSSC session and the application sessions is described in figure 3.

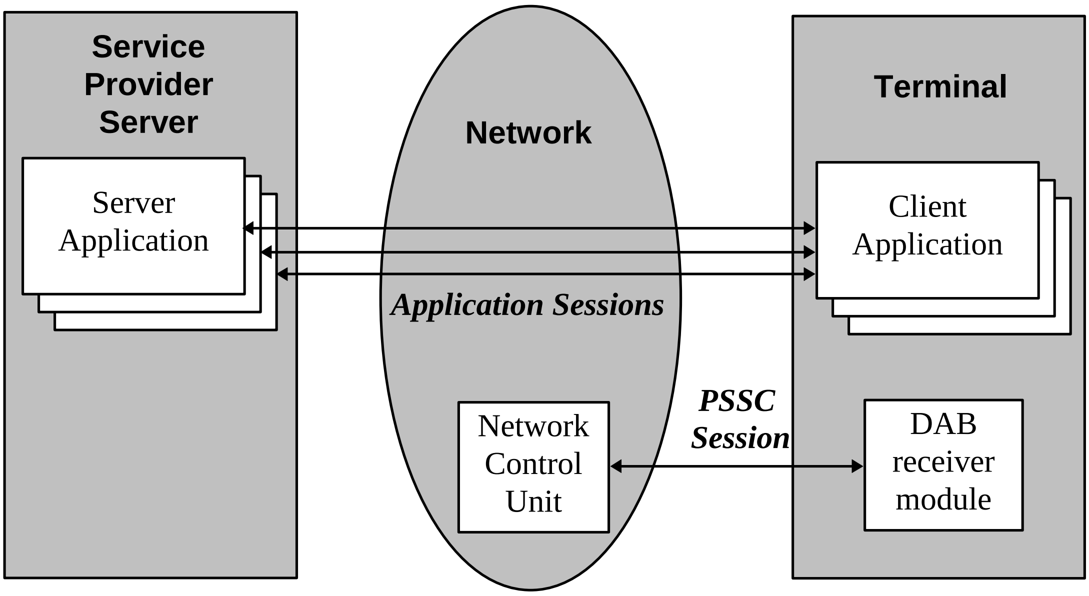
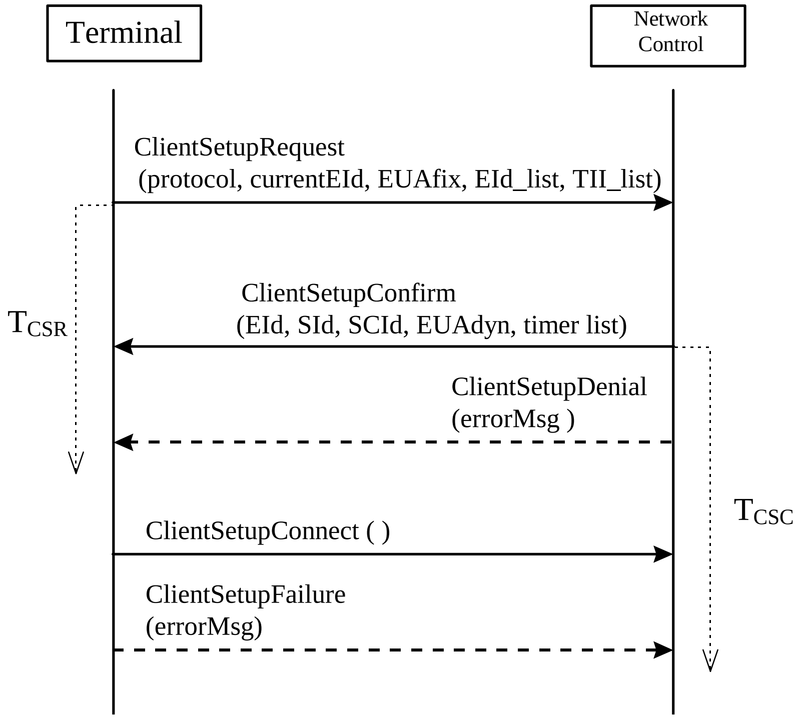


Figure 3: Relationship between PSSC session and application sessions

8.2 Session establishment

When an user terminal wants to establish a personal DAB service session, using TCP for PSSC transport, it first establishes a TCP connection to the network control unit TCP port number 645. After this connection has been established the client-initiated session set-up sequence described in figure 4 takes place. If UDP is used for PSSC transport, the datagrams containing PSSC messages shall be sent to the UDP port number 645 on the NCU.

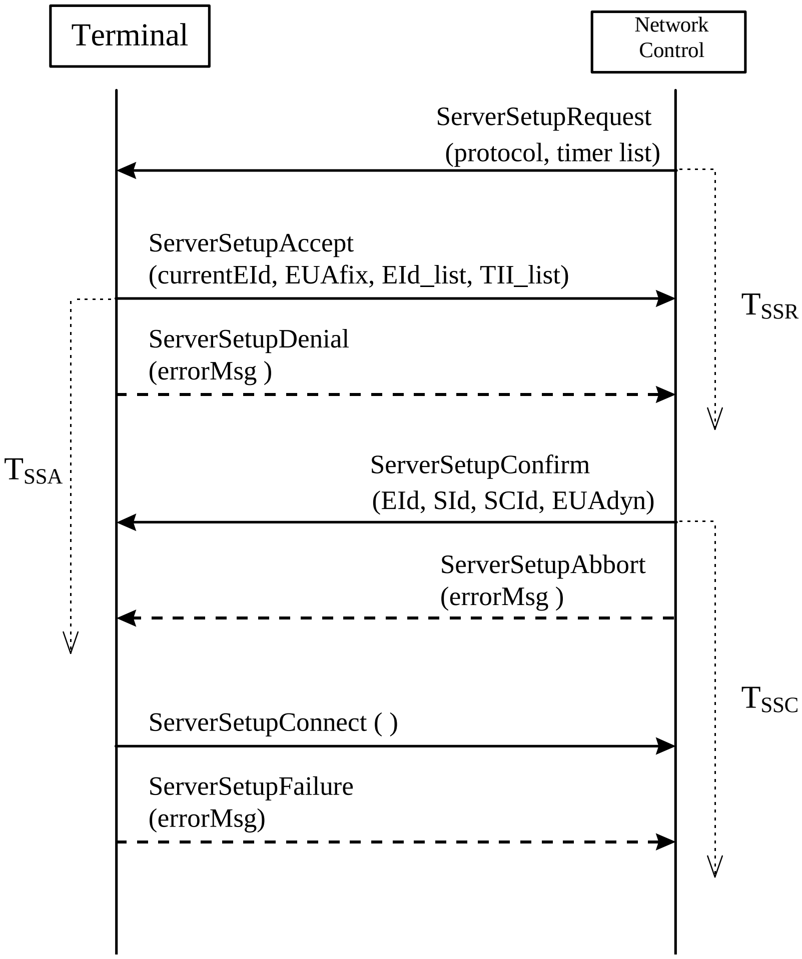


NOTE: If the NCU has an out standing ServerSetupRequest to the user terminal at the time when the ClientSetupRequest is received, the ClientSetupRequest shall be denied. If such situation occurs both parts shall wait a random time before they retry to establish a PSSC session.

Figure 4: Client initiated session set-up sequence

If the network wants to establish a personal DAB service session, using TCP for PSSC transport, it first establishes a TCP connection from the NCU unit to user terminal TCP port number 645. When this connection has been established the server-initiated session set-up sequence described in figure 5 takes place. If UDP is used for PSSC transport, the datagrams containing PSSC messages shall be sent to the UDP port number 645 on the user terminal.

NOTE: Server initiated session set-up is an optional feature that might not be supported by all user terminals.



NOTE: If the UT has an out standing ClientSetupRequest to the NCU at the time when the ServertSetupRequest is received, the ServerSetupRequest shall be denied. If such situation occurs both parts shall wait a random time before they retry to establish a PSSC session.

Figure 5: Server initiated session set-up sequence

8.3 Session release

When the user terminal wants to close the session, it uses the client-initiated session release sequence in figure 6. After that, the connection can be closed. After the network control unit has received the ClientReleaseRequest message, it can close all objects related to the session and shut down the service for the session.

Figure 6: Client-initiated session release sequence

If the network wants to close the session, it uses the server-initiated session release sequence in figure 7. After that, the connection can be closed. After the terminal has received the ServerReleaseRequest message, it can close all objects related to the session.

Figure 7: Server initiated session release sequence

8.4 Alive checking

If the user terminal wants to check that it still has contact with the network control unit it sends a ClientServeraliveCheck message. When the NCU receives a ClientServeraliveCheck message it will respond with a ClientServeraliveConfirm message. When the UT receives that message it will know that the PSSC session is still alive. If no ClientServeraliveConfirm message is received by the UT before the timer T_{CSaC} expires the user terminal will assume that the session is dead and close the connection. This client initiated alive check sequence is shown in figure 8.

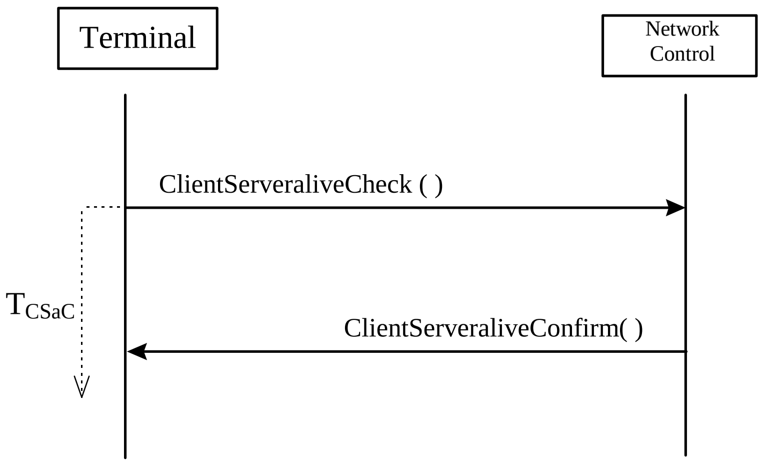


Figure 8: Client initiated alive check sequence

If the network control unit wants to check that it still has contact with the user terminal it sends a ServerClientaliveCheck message. When the UT receives a ServerClientaliveCheck message it will respond with a ServerClientliveConfirm message. When the NCU receives that message it will know that the PSSC session is still alive. If no ServerClientaliveConfirm message is received by the UT before the timer T_{SCaC} expires the NCU will assume that the session is dead and close the connection. This client initiated alive check sequence is shown in figure 9.

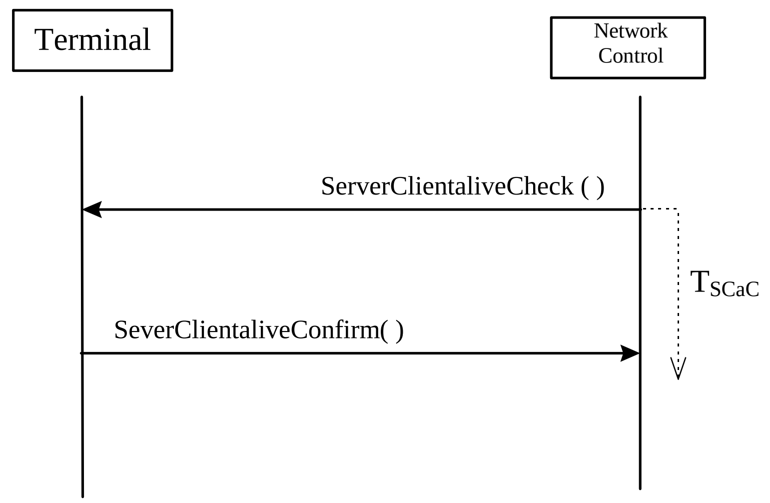


Figure 9: Server initiated alive check sequence

8.5 Handover

If the user terminal moves out of the coverage area for the DAB ensemble that it is currently tuned to it has to re-tune to another ensemble carrying the same personal DAB service. Before the UT can re-tune it has to inform and negotiate with the network about what ensemble to re-tune to. When that decision of new ensemble is made the UT re-tunes and the network re-routes to the new ensemble. This handover is controlled by the client-initiated handover sequence described in figure 10.

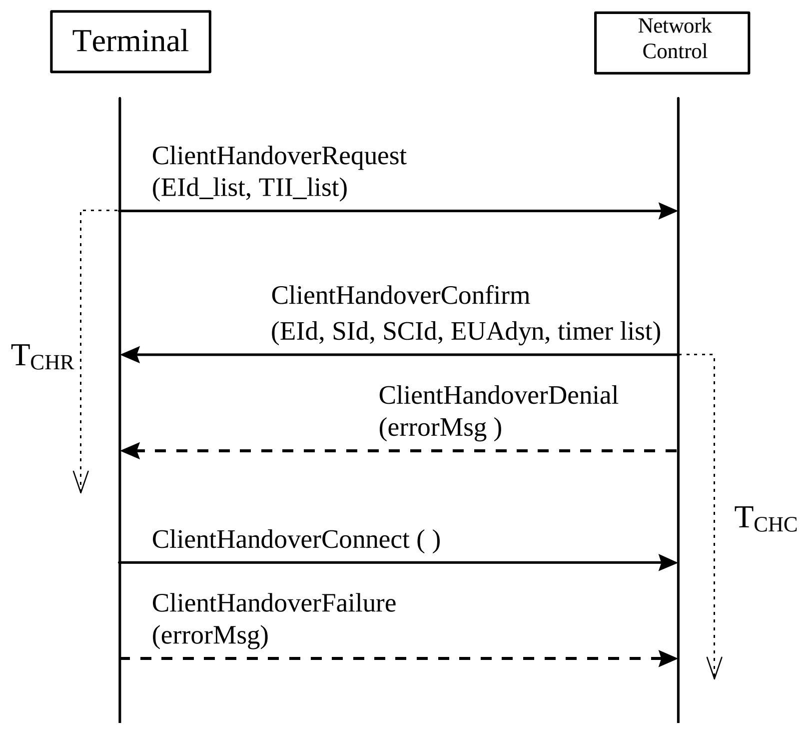


Figure 10: Client-initiated handover sequence

There are also cases when the network will initialize handover. This handover is controlled by the server-initiated handover sequence described in figure 11.

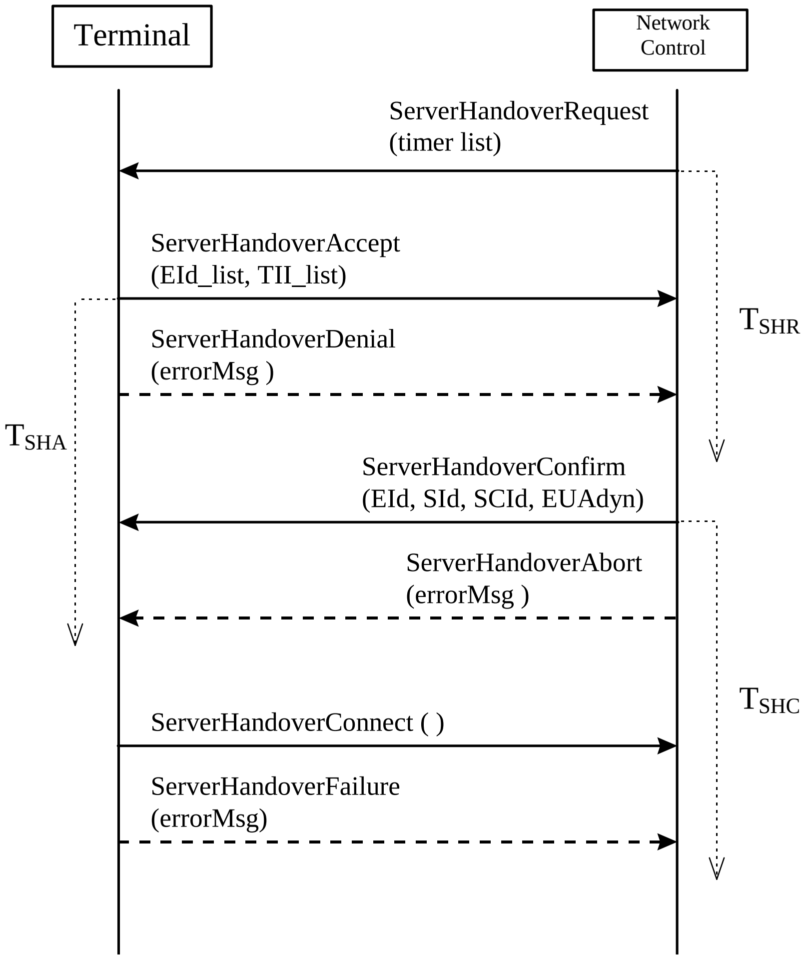


Figure 11: Server-initiated handover sequence

8.6 Temporary download through interaction channel

If the network looses DAB coverage it can order the network to re-route the download to the interaction channel. This is done by sending a ClientSignalLost to the network control unit. The network stops the download through DAB and confirms that the download will be done through the IC with a ClientISignalChange message. If the network is not able to re-route the download to the IC it will signal this with an ClientSignalDenial message. This signalling sequence is described in figure 12.

When the terminal gets DAB coverage again it can ask the network to re-route download to DAB by using the client-initiated handover sequence.

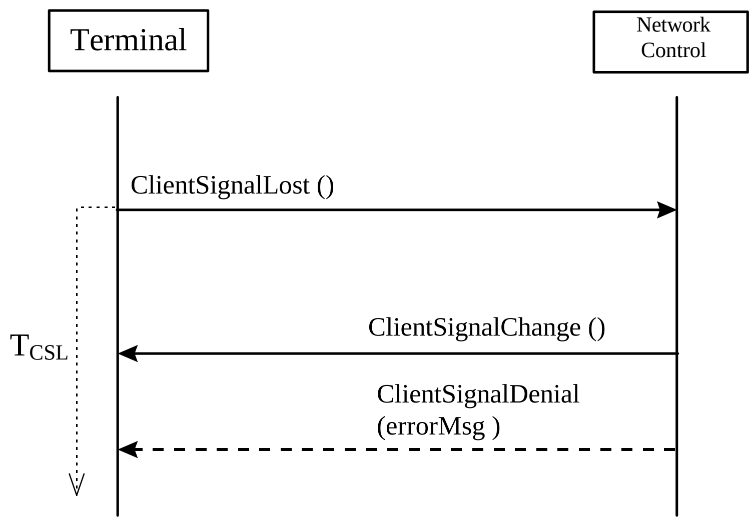


Figure 12: Client-initiated request for download through IC due to loss of DAB signal

9 PSSC message format

9.1 General

The general data structure of the PSSC messages is formed as in figure 13. The PSSC message consist of a PSSC header and 0 to 255 PSSC parameter fields.

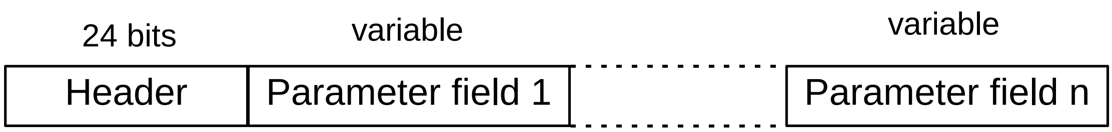


Figure 13: Data structure of the PSSC messages

9.2 PSSC header

The PSSC header is 24-bits long and the data structure is defined according to figure 14.

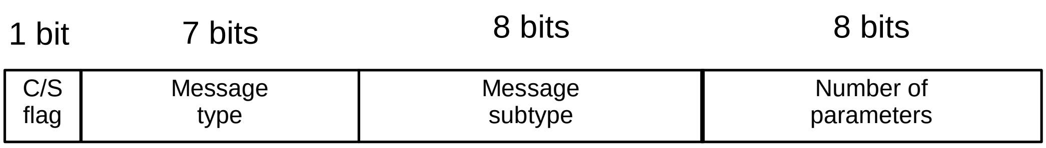


Figure 14: Data structure of the PSSC messages header field

Client/Server Initiation Flag (C/S flag): this 1-bit field indicates if the signalling sequence is initiated by the client (user terminal) or the server (network control unit) entity:

0: signalling sequence is initiated by the client (UT);

1: signalling sequence is initiated by the server (NCU).

Message type field: this 7-bit field specifies which PSSC sequence (see clause 8) the message belongs to. The interpretation of this field is specified in table 6.

Message subtype field: this 8-bit field specifies which message in the PSSC sequence that is carried. The interpretation of this field depends on the value of the message type field and is specified in table 6.

NOTE: The Rfu values of table 6 may be defined within TS 101 756 [4],without a formal update of the present document.

Table 6: Interpretation of message type field and message subtype field

Message type field	Message type name	Message subtype field	Message subtype name
0000000	Set-up	00000000 00000001 00000010 00000011 10000001 10000010 10000011 other	Request Accept Confirm Connect Denial Failure Abort Rfu
0000001	Release	00000000 other	Request Rfu
0000010	Client/Server-alive	00000000 00000001 other	Check Confirm Rfu
0000011	Handover	00000000 00000001 00000010 00000011 10000001 10000010 10000011 other	Request Accept Confirm Connect Denial Failure Abort Rfu
0000100	Signal	00000000 00000001 10000001 other	Lost Change Denial Rfu
1000000 : 1111111	Proprietary signalling	all	proprietary
other	Rfu	all	Rfu

Number of parameters field: this 8-bit field contains a binary encode unsigned integer (0 - 255) that indicates the number of PSSC parameter fields carried in the PSSC message.

9.3 PSSC parameter fields formats

9.3.1 General data structure of parameter fields

The structure of the parameter field is defined in figure 15.

6 bits	1 bit	1 bit	8 or 16 bits	n x 8 bits
Parameter Identifier	R/O flag	Ext. flag	Data field length indicator, *n*	Data field

Figure 15: Data structure of PSSC parameter field

Parameter identifier: this 6-bit field identifies the type of parameter. The coding of the parameter types is defined in table 7.

NOTE: The Rfu values of table 7 may be defined within TS 101 756 [4], without a formal update of the present document.

Table 7: Interpretation of parameter identifier field

Parameter identifier	Parameter name	R/O flag	Data filed length	Interpretation
000000	DAB protocol	0	1 byte	see clause 9.3.2, D1
000001	Ensemble identifier	0	2 byte	see clause 9.3.2, D2
000010	Service identifier	0	2 byte	see clause 9.3.2, D3
000011	Service component identifier	0	2 byte	see clause 9.3.2, D4
000100	End user address	0	variable	see clause 9.3.2, D5
000101	Ensemble identifier list	0	variable	see clause 9.3.2, D6
000110	Transmitter identification information list	0/1	variable	see clause 9.3.2, D7
000111	Text message	0/1	variable	see clause 9.3.2, D8
001000	Timer list	0/1	variable	see clause 9.3.2, D9
001001 : 011111	Rfu	not specified	not specified	not specified
100000 : 111111	Proprietary parameter	0/1	proprietary	proprietary

R/O Flag (Required/Optional flag): this 1-bit field indicates how the receiving part shall handle a unrecognized parameter identifier. The following definitions applies:

0: the parameter is required for the functionality of this PSSC message. Ignore the whole PSSC message if parameter identifier is unrecognized;

1: the parameter is optional (not required) for the functionality of this PSSC message. Ignore only this parameter if parameter identifier is unrecognized.

The allowed values of the R/O flag are listed in table 7.

Ext. Flag (Extension Flag): this 1-bit field specifies the length of the data field length indicator and is coded as follows:

0: the data field length indicator is 8 bits long;

1: the data field length indicator is 16 bits long.

Data field length indicator: this field specifies as an unsigned binary integer the length of the data field in bytes. The length of the field is either 8 or 16 bits depending on the value of the extension flag.

Data field: this field contains the parameter data as specified in clause 9.3.2. The length of the field is variable and signalled in the data field length indicator.

9.3.2 Data field structure of parameter field

D1. DAB Protocol: 8-bit data field that contains information about which protocols that shall be used in the broadcast channel during a personal DAB session. This field is used to carry protocol parameter in the session signalling described in clause 8 of the present document. The protocol parameter is encoded as follows:

0 0 0 0 0 0 0 0: MOT in packet mode (see EN 301 234 [1]);

0 0 0 0 0 0 0 1: IP datagram tunnelling in packet mode (see TS 101 735 [5]);

other: Rfu.

NOTE: The Rfu values of the DAB protocol field may be defined within TS 101 756 [4], without a formal update of the present document.

D2. Ensemble Identifier (EId): 16-bit field that contains an ensemble identifier as specified in ETS 300 401 [2]. This field is used to carry the current EId and the EId parameters in the session signalling described in clause 8 of the present document.

D3. Service Identifier (SId): 32-bit field that contains a 32-bit service identifier as specified in ETS 300 401 [2]. This field is used to carry the SId parameter in the session signalling described in clause 8 of the present document.

D4. Service Component Identifier (SCId): the 12 least significant bits of this 16-bit field contains a service Component identifier as specified in ETS 300 401 [2]. The 4 most significant bits are Rfu and shall be set to 0 0 0 0. This field is used to carry the SCId parameter in the session signalling described in clause 8 of the present document.

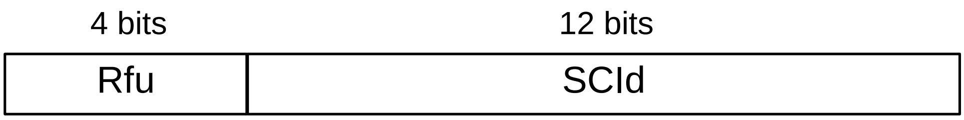


Figure 16: Data structure of the service component identifier parameter field

D5. End User Address (EUA): a *n* x 8 bit field that contains the end user address of the user terminal. The number of octets, *n,* in the field is equal to the value of the data field length indicator specified in clause 9.3.1. For EUA only the data field length indicator values in the interval 1 to 15 are legal. This field is used to carry the EUA parameter in the session signalling described in clause 8 of the present document.

D6. Ensemble Identifier List (Eid List): a *m* x 16 bit field that contains a list of *m* EId's (as specified in ETS 300 401 [2]) of ensembles available for the user terminal. The number of sub-fields, *m* in the EId list is equal to half the value of the data field length indicator specified in clause 9.3.1. The order of the EId in the list gives their priority. The first EId in the list has highest priority. This field is used to carry the EId list parameter in the session signalling described in clause 8 of the present document.

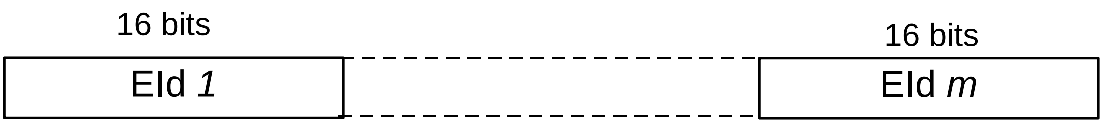


Figure 17: Data structure of the ensemble identifier List parameter field

D7. Transmitter Identification Information List (TII list): a *i* x 16 bit field that contains a list of *i* TII of transmitters available for the terminal. The TII's are derived from the DAB synchronization channel as specified in ETS 300 401 [2]. The number of sub-fields, *i,* in the TII list is equal to half the value of the data field length indicator specified in clause 9.3.1. The order of the TII in the list gives their priority. The first TII in the list has highest priority. This field is used to carry the TII list parameter in the session signalling described in clause 8 of the present document.

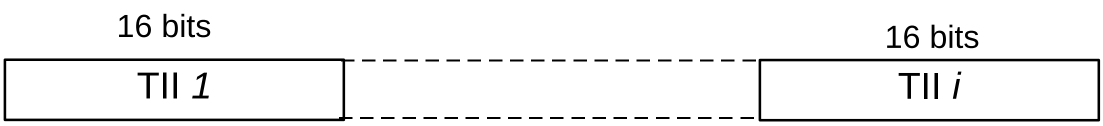


Figure 18: Data structure of the transmitter identification information list parameter field

The TII sub-fields in the list are defined by figure 19. The *c* field contains the comb number *c* as defined in ETS 300 401 [2]. The *p* field contains the pattern number *p* as defined in ETS 300 401 [2]. The *c* and *p* are coded as unsigned binary numbers with the following values:

- $0 \le c \le 23$
- $0 \le p \le 69$ for DAB transmission mode I, II and IV
- $0 \le p \le 5$ for DAB transmission mode III

All other values of c and p shall be regarded as illegal.

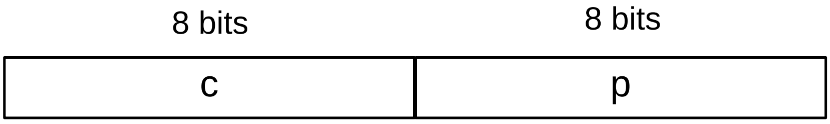


Figure 19: Data structure of the transmitter identification Information carried in the TII sub-fields

D8. Text Message field (TxtMsg): a *j* x 8 bit field used to carry a *j* character long text string. The number of characters, *j*, in the field is equal to the value of the data field length indicator specified in clause 9.3.1. The characters shall be encoded in the *ISO Latin Alphabet No 1*, see ISO/IEC 8859-1 [11].

The text string can be used for error messages or other messages that may displayed by the terminal. The TxtMsg can be used as an optional parameter to all messages in the PSSC protocol.

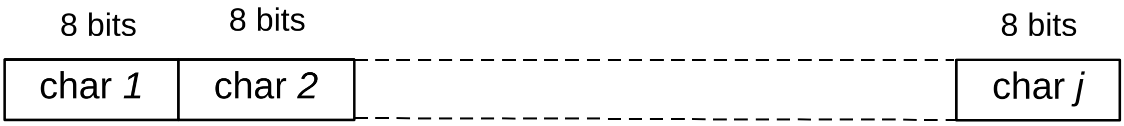


Figure 20: Data structure of the text field parameter field

D9. Timer list: a *k* x 16 bit field that carries a list of *k* timers that can be downloaded to the terminal from the network as described in clause 8. The number of sub-fields, *k,* in the timer list is equal to half the value of the data field length indicator specified in clause 9.3.1.

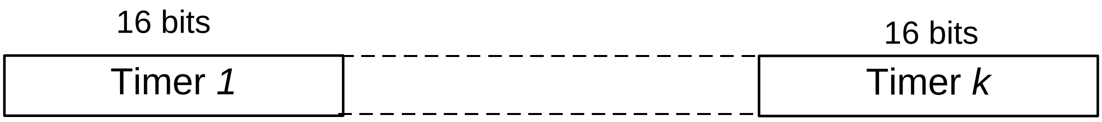


Figure 21: Data structure of the timer list parameter field

The structure of the timer sub-fields is defined in figure 22. The TimerId indicates which timer, in clause 8, the timer value reefers to. The interpretation of the TimerId is specified in table 8. The timer value carries the time out time for the timer in seconds, coded as a 8 bit unsigned binary number. The timer value 00000000 has the special meaning of undefined and indicates that the user terminal shall set this value by it self.

NOTE: The Rfu values of table 8 may be defined within TS 101 756 [4], without a formal update of the present document.

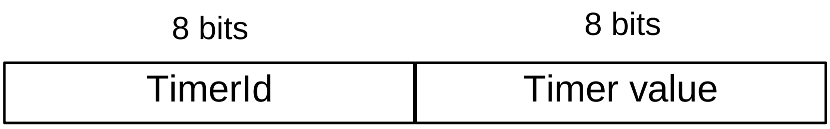


Figure 22: Data structure of the timer information carried in the timer sub-fields

Table 8: Interpretation of TimerId

Timer Id	Timer name	Shortage	Usage
00000000	ClientSetupRequest timer	T_{CSR}	See clause 8.2
00000001	ClientSetupConfirm timer	T_{CSC}	See clause 8.2
00000010	ServerSetupRequest timer	T_{SSR}	See clause 8.2
00000011	ServerSetupAccept timer	T_{SSA}	See clause 8.2
00000100	ServerSetupConfirm timer	T_{SSC}	See clause 8.2
00000101	ClientServeraliveCheck timer	T_{CSaC}	See clause 8.4
00000110	ServerClientaliveCheck timer	T_{SCaC}	See clause 8.4
00000111	ClientHandoverRequest timer	T_{CHR}	See clause 8.5
00001000	ClientHandoverConfirm timer	T_{CHC}	See clause 8.5
00001001	ServerHandoverRequest timer	T_{SHR}	See clause 8.5
00001010	ServerHandoverAccept timer	T_{SHA}	See clause 8.5
00001011	ServerHandoverConfirm timer	T_{SHC}	See clause 8.5
00001100	ClientSignalLost timer	T_{CSL}	See clause 8.6
10000000 : 11111111	Proprietary timers	not specified	proprietary
other	Rfu	not specified	not specified

Annex A (informative): Guidelines for choice of protocols for interactive services

A.1 General

When an interactive services is implemented it is necessary to choose an appropriate combination of the protocols specified in clause 5.2 of the present document. A helpful tool for this choice is to evaluate the characteristics of the application that shall be used. This can be done by classifying the application as:

1) **local interaction:** data broadcasting in DAB. No interaction channel required;
2) **one-way interaction:** data broadcasting in DAB. Individual data transfer from user terminal to service provider via the IC;
3) **two-way interaction, personal FBC services:** data broadcasting in DAB. Individual data transfer from user terminal to service provider and from service provider to user terminal via the IC;
4) **two-way interaction, personal DAB services:** individual data transfer from service provider to user terminal via DAB. Individual data transfer from UT to service provider via IC.

The subsequent parts of this appendix contains guidelines how to choose protocols for cases 2 to- 4. Case 1, local interactive, is not taken in account in the present document, since it does not require an interaction channel.

A.2 One-way interaction

For one-way interaction is it recommended to use the MOT protocol stack specified in clause 5.2.1, table 1 for the broadcast channel and the protocol stack specified in clause 5.2.2, table 3 for the interaction channel.

NOTE: The GSM-SMS alternative for the interaction channel is suitable only for very small interaction messages. Each message is restricted to 160 7-bit characters or 140 8-bit characters (bytes).

A.3 Two-way interaction, personal FBC services

For two-way interaction, personal FBC services is it recommended to use the MOT protocol stack specified in clause 5.2.1, table 1 for the broadcast channel and the protocol stack specified in clause 5.2.2, table 3 for the interaction channel.

NOTE: The GSM-SMS alternative for the IC is suitable only for very small interaction messages. Each message is restricted to 160 7-bit characters or 140 8-bit characters (bytes).

A.4 Two-way interaction, personal DAB services

For two-way interaction, personal DAB services two combinations of protocols may be chosen:

1) the MOT protocol stack specified in clause 5.2.1, table 1 for the DAB channel and the protocol stack specified in clause 5.2.2, table 4 for the interaction channel;
2) the IP-tunnelling protocol stack specified in clause 5.2.1, table 2 for the DAB channel and the protocol stack specified in clause 5.2.2, table 4 for the interaction channel.

In the case of MOT in the DAB channel it has to be considered that the two channels do not have an common addressing scheme in the layers specified by the present document. This implies that the mapping of the different address in the broadcast and interaction channel shall be done in the higher layers.

In the case of IP tunnelling in DAB the IP-address can be used as the common addressing scheme for both the DAB and the interaction channel.

For personal DAB services only the packet mode alternative shall be used. The PAD is not suitable for this type of service. This since PAD is constructed for data related to the audio program and therefore does not has any separate service signalling, which is required for the PSSC protocol.

To use two-way interaction, personal DAB in a multi-frequency DAB network is it strongly recommended to use the PSSC protocol (see, clause 5.3.3, clauses 8 and 9) for controlling of the personal DAB session. It is also recommended to use the PSSC protocol for control of these services in a single-frequency DAB network.

Annex B (normative): Guidelines for set-up and handover for personal DAB service sessions

B.1 General

In the case of PSSC is needed in order to co-ordinate the data flow between the broadcast channel and the interaction channel. The session control signalling is done within the IC and is bi-directional. If the session control protocol is used, the protocol stack shall be as defined in clause 5.3.3 of the present document.

If the main traffic in the DAB network is individually addressed (as for personal DAB services) it is recommended to use a cellular DAB networks in order to be able to serve large number of simultaneous users in the network (compare with transmitter networks for cellular phones), in contrast to broadcasting where SFN's are used. Cellular networks on the other hand generates the problem of roaming, in other words keeping track on in which cell the user currently is, and routing/switching, to pipe his requested information to the right transmitter/cell. There is also the problem of if the user is mobile and moving from the coverage area of one cell to another which creates handover. Considering handover there is also the requirement that the network is not allowed to drop/loose information indented to a user during handover.

The PSSC protocol supports the solution of these problems.

B.2 Personal DAB service session set-up

The set-up of a personal DAB service session consists of two phases:

1) phase 1, establishing a session control connection between the user terminal and the network control unit;

2) phase 2, establishing the data connection between the user terminal and the service provider with DAB as down-link and FBC as up-link.

The set-up procedure can be initiated by the user terminal and as an optional case by the network (service provider):

B.2.1 Initiated by the user terminal

B.2.1.1 Phase 1

The UT establishes a physical and data link layer connection with the interaction network adapter over the interaction network. To do this the UT has to know how to address the network adapter, e.g. a phone number to a modem pool.

If dynamic IP-addresses are used the server over the INA assigns the UT an IP address using the standard Internet protocol for dynamic IP assignment.

If TCP is used for transport of PSSC the UT establish a TCP/IP connection to the NCU.

B.2.1.2 Phase 2

The UT sends a PSSC ClientSetupRequest message to the NCU. This message contains information about the protocol the UT likes to use in DAB (packet mode IP tunnelling or packet mode MOT) and the EId of the ensemble currently tuned to. If known the UT can also provide the NCU with lists of other EId and/or TII possible to receive in the UT's current location. If the UT has an fixed EUA this is also sent to the NCU.

The NCU (roaming system) makes a decision, based on available capacity and transmitters covering the UT, and assigns an EId, SId, and SCId that the personal DAB service session will use. If dynamic assignment of EUA is used the NCU also assigns a EUA. This information is downloaded in the PSSC ClientSetupConfirm message through the IC to the user terminal. Since the optimal timer values for the PSSC protocol depends on the available channels, the NCU can download the valid timer values in a timer list in the ClientSetupConfirm message. If the NCU is unable to assign a channel for the personal DAB service session a ClientSetupDenial is downloaded containing a text string with an error message that can be displayed to the user.

The UT uses the EId, SId, SCId to tune to the DAB channel where it can find the data with it's EUA. When tuned the UT sends a PSSC ClientSetupConnect message to the NCU indicating that it is ready to receive personal data over the DAB channel. If of some reason the UT can't find the DAB service component assigned it sends a PSSC ClientSetupFailue message instead of the PSSC ClientSetupConnect message to indicate that the set-up procedure should be aborted.

The network and terminal can now use DAB as down-link and IC as up-link for the personal DAB service and a connection between the user terminal and the service provider can be established.

B.2.2 Initiated by the network

B.2.2.1 Phase 1

The service provider indicates to the network control unit that it wants to connect a certain user terminal.

The interaction network adapter establishes a physical and data link layer connection with the user terminal over the interaction network. To do this the user terminal has to know how to address the UT, e.g. a phone number. This address could be retrieved from a database or from the service provider during step 1.

If dynamic IP-addresses are used the server over the interaction network adapter assigns the UT an IP address using the standard Internet protocol for dynamic IP assignment.

If TCP is used for transport of PSSC the NCU establish a TCP/IP connection to the UT.

B.2.2.2 Phase 2

The NCU then sends a PSSC ServerSetupRequest message to the UT. This message contains information about the protocol the UT likes to use in DAB (packet mode IP-tunnelling or packet mode MOT). Since the optimal timer values for the PSSC protocol depends on the available channels, the NCU can download the valid timer values in a timer list in the ServerSetupRequest message.

The UT sends a PSSC ServerSetupAccept message to the NCU. This message contains information about the EId of the ensemble currently tuned to. If known the UT can also provide the NCU with lists of other EId and/or TII possible to receive in the UT's current location. If the UT has an fixed EUA this is also sent to the NCU. If the UT can't establish a personal DAB service session a ServerSetupDenial message is sent instead of the ServerSetupAccept.

The NCU (roaming system) makes a decision, based on available capacity and transmitters covering the UT, and assigns an EId, SId, and SCId that the personal DAB service session will use. If dynamic assignment of EUA is used the NCU also assigns a EUA. This information is downloaded in the PSSC ServerSetupConfirm message through the IC to the UT. If the NCU is unable to assign a channel for the personal DAB service session a ServerSetupAbbortl is downloaded containing a text string with an error message that can be displayed to the user.

The UT uses the EId, SId, SCId to tune to the DAB channel where it can find the data with it's EUA. When tuned the UT sends a PSSC ServerSetupConnect message to the NCU indicating that it is ready to receive personal data over the DAB channel. If of some reason the UT can't find the DAB service component assigned it sends a PSSC ServerSetupFailue message instead of the PSSC ServerSetupConnect message to indicate that the set-up procedure should be aborted.

The network and terminal can now use DAB as down-link and IC as up-link for the personal DAB service.

B.3 Personal DAB service session handover

In a cellular network it can be necessary to change DAB ensemble for the personal DAB service during a session, e.g. when a mobile UT moves out of the coverage area of it's current DAB transmitter. The handover is signalled with the PSSC protocol over the IC between the network control unit and the UT.

B.3.1 Initiated by the user terminal

The UT sends a PSSC ClientHandoverRequest message to the NCU. If known the UT provides the NCU with lists of other EId and/or TII possible to receive in the UTs current location.

The NCU (roaming system) makes a decision, based on available capacity and transmitters covering the UT, and assigns an new EId, SId, and SCId that the personal DAB service session will use. If dynamic assignment of EUA is used the NCU also assigns a new EUA. This information is downloaded in the PSSC ClientHandoverConfirm message through the IC to the UT. Since the optimal timer values for the PSSC protocol depends on the available channels, the NCU, as an option, can download the new timer values in a timer list in the ClientHandoverConfirm message. If the NCU is unable to assign a new channel for the personal DAB service session a ClientHandoverDenial is downloaded containing a text string with an error message that can be displayed to the user. When the ClientHandoverConfirm message has been sent the network shall pause the transmission of data over DAB to the UT to guarantee that no data is lost during re-tuning of the DAB receiver.

The UT uses the EId, SId, SCId to re-tune to the new DAB channel where it can find the data with it's EUA. Then tuned the UT sends a PSSC ClientHandoverConnect message to the NCU indicating that it is ready to receive personal data over the new DAB channel. If of some reason the UT can't find the DAB service component assigned it sends a PSSC ClientHandoverFailure message instead of the PSSC ClientHandoverConnect message to indicate that the handover procedure should be aborted.

When the network receives the ClientHandoverConnect message it can start down-loading data through DAB again.

B.3.2 Initiated by the network

The NCU sends a ServerHandoverRequest to indicate that it wants to start the handover procedure. Since the optimal timer values for the PSSC protocol depends on the available channels, the NCU, as an option, can download the new timer values in a timer list in the ServerHandoverRequest message.

The UT sends a PSSC ServerHandoverAccept message to the NCU. If known the UT provides the NCU with lists of other EId and/or TII possible to receive in the UTs current location. If the UT can't accept a handover a ServerHandoverDenial is sent.

The NCU (roaming system) makes a decision, based on available capacity and transmitters covering the UT, and assigns an new EId, SId, and SCId that the personal DAB service session will use. If dynamic assignment of EUA is used the NCU also assigns a new EUA. This information is downloaded in the PSSC SeverHandoverConfirm message through the IC to the UT. If the NCU is unable to assign a new channel for the personal DAB service session a SeverHandoverAbbort is downloaded containing a text string with an error message that can be displayed to the user. When the SeverHandoverConfirm message has been sent the network shall pause the transmission of data over DAB to the UT to guarantee that no data is lost during re-tuning of the DAB receiver.

The UT uses the EId, SId, SCId to re-tune to the new DAB channel where it can find the data with it's EUA. When tuned the UT sends a PSSC SeverHandoverConnect message to the NCU indicating that it is ready to receive personal data over the new DAB channel. If of some reason the UT can't find the DAB service component assigned it sends a PSSC SeverHandoverFailure message instead of the PSSC SeverHandoverConnect message to indicate that the handover procedure should be aborted.

When the network receives the SeverHandoverConnect message it can start down-loading data through DAB again.

History

Document history		
V1.1.1	July 2000	Membership Approval Procedure MV 20000915: 2000-07-18 to 2000-09-15
V1.1.1	September 2000	Publication