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Digital Audio Broadcasting (DAB); Data Broadcasting - Transparent Data Channel (TDC)

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Foreword

This Technical Specification (TS) 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).

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, EN 300 401 [1], for DAB (see note 2) 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.

Introduction

The Transparent Data Channel (TDC) specification provides DAB with the ability to transport simple data streams using a variety DAB data channels. In a simple stream, data bytes are processed sequentially by the receiver in the order in which they are received but there is no implied beginning or end to the data. Any "framing" of data within the stream is determined purely by the application protocol that is carried by the stream.

Three forms of the Transparent Data Channel are specified here:

- TDC in a packet mode service component;
- TDC in a stream mode service component;
- TDC in an audio service component carried as X-PAD.

The Transparent Data Channel complements the MOT specification by allowing DAB to transport data in the form of *streams* as well as *files*. It is intended that applications that rely on simple stream transport, such as the TPEG and DGPS protocols, can be supported in DAB simply by specifying the use of the Transparent Data Channel for data transport.

The present document has removed the "byte stuffing" mechanism previously defined for TDC carried as X-PAD as this was found to cause some decoding difficulties. In addition, data groups may be used in X-PAD.

1 Scope

The present document specifies how to transport data transparently within the Digital Audio Broadcasting (DAB) system forming a Transparent Data Channel (TDC) and gives guidelines for its use.

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- | | |
|-----|--|
| [1] | ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers". |
| [2] | ETSI TR 101 496 (all parts): "Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation". |
| [3] | ETSI EN 301 234: "Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol". |

3 Abbreviations and syntax specification

3.1 Abbreviations

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

CCITT	International Consultative Committee for Telegraph and Telephone
CRC	Cyclic Redundancy Check
DAB	Digital Audio Broadcasting
F-PAD	Fixed - Programme Associated Data
MOT	Multimedia Object Transfer
MSC	Main Service Channel
PAD	Programme Associated Data
TCP	Transmission Control Protocol
TDC	Transparent Data Channel
TPEG	Transport Protocol Experts Group
X-PAD	eXtended - Programme Associated Data

3.2 Syntax specification

The specifications of syntax that appear in the present document are written using a form of pseudo-code that is similar to the procedural language "C"; this provides for easy specification of loops and conditional data structures. Within these specifications, the type of individual data fields is expressed using the mnemonics given in table 1-1.

Table 1-1: Data type mnemonics for syntax specification

Mnemonic	Description
uimsbf	Unsigned integer, most significant bit first
bslbf	Bit string, left bit first
rpchof	Remainder polynomial coefficients, high order first

4 Transparent Data Channel specification

The MOT protocol allows transportation of objects - this is achieved either by using simple MOT transport for non-ordered data objects or by using a data carousel for a managed set of data files. As a complement to this, the Transparent Data Channel allows simple stream data to be delivered to support stream based applications (for example TPEG).

The TDC specification described below is based on the mechanisms that are provided by EN 300 401 [1] for data delivery:

- Packet mode service component.
- Data in an audio service Component using X-PAD.

The implementation of these basic mechanisms is explained in more details in TR 101 496 [2].

4.1 TDC in a packet mode service component

TDC data carried in a packet mode service component may be organized either with or without the MSC data group structure defined by EN 300 401 [1].

The use of data groups for establishing a transparent data channel provides:

- Error control by using data group repetition.
- The ability to guarantee that "chunks" of data from the stream are delivered to the receiver (or lost) as a coherent sets of data.
- Optional addressing of end users.

Where the features above are not required, not using data groups for the TDC provides:

- Low overhead.
- Low latency.
- Simple processing requirements.

The two forms of the TDC in a packet mode service component are specified in the following paragraphs.

4.1.1 TDC in a packet mode service component without data groups

Packet mode sub-channels use a simple packet protocol to allow a number of separate data services to be multiplexed into a single DAB sub-channel. Carriage of simple stream data in such a channel is implemented by sending packets containing the data *when there is data to send*. The structure of DAB packets is shown in table 2-1.

Table 2-1: Structure of a DAB packet

Syntax	Size	Type
DAB_packet() {		
packet_length	2 bits	uimsbf
continuity_index	2 bits	uimsbf
first_flag	1 bit	bslbf
last_flag	1 bit	bslbf
packet_address	10 bits	uimsbf
command_flag	1 bit	bslbf
useful_data_length	7 bits	uimsbf
for (i=0;i<useful_data_length;i++) {		
packet_data_byte	8 bits	uimsbf
}		
for (i=0;i<N;i++) {		
padding_byte	8 bits	uimsbf
}		
packet_CRC	16 bits	rpchof
}		

packet_length: This field can take one of four values to indicate the overall size of the packet in multiples of 24 bytes. The maximum length of the payload of each packet is equal to the overall packet length minus the 5 bytes of packet overhead. The overall packet length may be determined from the *packet_length* field by the formula $(packet_length + 1) \times 24$, thus a *packet_length* of 0 indicates an overall packet length of 24 bytes and a *packet_length* of 3 indicates an overall packet length of 96 bytes.

continuity_index: The *continuity_index* is incremented by one for each successive packet that is sent **for a particular packet_address**.

first_flag: The *first_flag* is used to indicate (when set to 1) that the packet is the first packet in a series of packets that are to be assembled into an MSC data group.

last_flag: The *last_flag* is used to indicate (when set to 1) that the packet is the last packet in a series of packets that are to be assembled into an MSC data group.

packet_address: The *packet_address* is a 10 bit number that identifies packets for a particular data service component within the multiplex of components for a packet mode sub-channel.

useful_data_length: The *useful_data_length* field identifies the number of bytes within the payload of the packet that are to be considered to be carrying useful data.

packet_data_byte: These fields carry the useful payload for each individual packet.

padding_byte: The *padding_bytes* are used to fill the remainder of the packet after the *packet_data_bytes* and shall be set to 0.

packet_CRC: The *packet_CRC* field is calculated, according to the CCITT CRC-16 polynomial, over the entire packet, with the CRC register initialized to all 1s and the resulting CRC inverted.

Within a packet mode sub-channel, packets may be assembled into larger, variable length datagrams known as MSC data groups. The assembly of packets into data groups is controlled by the first and last flags, as shown in table 2-2.

Table 2-2: Interpretation of first and last flags

first_flag	last_flag	Interpretation
0	0	The packet is an intermediate packet in a series of packets
0	1	The packet is the last packet in a series of packets
1	0	The packet is the first packet in a series of packets
1	1	The packet is the one and only packet

In order to carry stream data in this very simple way, the data is sent in packets with the first_flag and the last_flag both set to zero, thus indicating that the data carried by the packets is simply an intermediate part of a stream with no specific start or end. Marking the packets in this way ensures that no receiver will ever attempt to incorrectly assemble asynchronous stream data into data groups.

The use of data groups in TDC depends upon the DG flag in FIG 0/3 (see EN 300 401 [1]). When set to '0', data groups are used, when set to '1' no data groups are used.

4.1.2 TDC in a packet mode service component with data groups

In order to carry stream data, the data is put into a data group, which in turn is sent in packets.

Table 2-3: Structure of an MSC data group

Syntax	Size	Type
MSC_data_group() {		
MSC_data_group_header() {		
extension_flag	1	bslbf
CRC_flag	1	bslbf
segment_flag	1	bslbf
user_access_flag	1	bslbf
data_group_type	4	uimsbf
continuity_index	4	uimsbf
repetition_index	4	uimsbf
if (extension_flag == 1) {		
extension_field	16	bslbf
}		
}		
session_header() {		
if (segment_flag == 1) {		
last	1	bslbf
segment_number	15	uimsbf
}		
if (user_access_flag == 1) {		
user_access_field () {		
rfa	3	bslbf
transport_id_flag	1	bslbf
length_indicator	4	uimsbf
if (transport_id_flag == 1) {		
transport_id	16	uimsbf
}		
end_user_address_field() {		
for (n=0;n<length_indicator-2;n++) {		
end_user_address_byte	8	uimsbf
}		
}		
}		
}		
}		
MSC_data_group_data_field() {		
for (i=0;i<data_group_length;i++) {		
data_group_data_byte	8 bits	uimsbf
}		
}		

Syntax	Size	Type
<pre> if (CRC_flag==1) { MSC_data_group_CRC } </pre>	16 bits	rpchof

extension_flag: The *extension_flag* indicates (when set to 1) that the *extension_field* is present.

crc_flag: The *crc_flag* indicates (when set to 1) that the *MSC_data_group_CRC* is present.

segment_flag: The *segment_flag* indicates (when set to 1) that the *segment_number* and last Flag in the *session_header* are present.

user_access_flag: The *user_access_flag* indicates (when set to 1) that the *user_access_field* in the *session_header* is present.

data_group_type: For TDC the *data_group_type* shall be set to 0.

continuity_index: The *continuity_index* shall be incremented each time a data group with a content different from that of the preceding data group is transmitted.

repetition_index: The *repetition_index* shall signal the remaining number of repetitions of a data group with the same content. Exceptionally, the code '1111' shall be used to signal that the repetition continues for an undefined period.

extension_field: The *extension_field* is reserved for future use in TDC.

last: The *last* flag shall indicate that the current data group is the last in a sequence of data groups with the same *transport_id* that carry the data for a coherent "chunk" of data from the TDC.

segment_number: The *segment_number* shall indicate the segment number of the current data group when a coherent "chunk" of data (identified by the *transport_id*) is being transmitted that is longer than a single data group.

rfa: Reserved for future additions. Shall be set to '0'.

transport_id_flag: For TDC, the *transport_id_flag* shall indicate (when set to 1) that the *transport_id* field is present.

length_indicator: The *length_indicator* shall indicate the length *n* in bytes of the *transport_id* and the *end_user_address_field*.

transport_id: For TDC, the *transport_id* (if needed) shall be identical for all different segments forming a specific "chunk". It shall be changed for each coherent "chunk" of data.

end_user_address_byte: The *end_user_address_bytes* shall be used to distinguish between different TDC data streams for different terminals. Its use depends upon the application (ApplicationId in FIG0/13) and is not subject to the present document.

MSC_data_group_data_byte: The *MSC_data_group_data_bytes* shall contain the data for the transparent data channel.

MSC_data_group_CRC: The *MSC_data_group_CRC* field is calculated, according to the CCITT CRC-16 polynomial, over the *MSC_data_group_header*, the *session_header* and the *MSC_data_group_data_field*, with the CRC register initialized to all 1s and the resulting CRC inverted.

4.2 TDC in a stream mode service component

In a stream mode service component, all the data for the sub-channel is assumed to be part of the stream. This means that a Transparent Data Channel carried in a stream mode service component is an essentially synchronous (i.e. fixed bit rate) stream.

4.3 TDC in an audio service component using X-PAD

TDC data carried in X-PAD may be organized either with or without the MSC data group structure defined by EN 300 401 [1].

The use of data groups for establishing a transparent data channel provides:

- Error control by using data group repetition.
- The ability to guarantee that "chunks" of data from the stream are delivered to the receiver (or lost) as a coherent sets of data.
- Optional addressing of end users.

Where the features above are not required, not using data groups for the TDC provides:

- Low overhead.
- Low latency.
- Simple processing requirements.

The two forms of the TDC in X-PAD are specified in the following clauses.

Two forms of X-PAD are available and the precise interpretation of the X-PAD sub-field for the TDC depends on the type of X-PAD that is being used. In "short" X-PAD, a single field of either 3 bytes or 4 bytes is present in each audio frame. In "variable length" X-PAD, up to four X-PAD sub-fields of up to 48 bytes each can be present in each audio frame. The two cases are described in detail below.

4.3.1 TDC in X-PAD without data groups

X-PAD uses a simple protocol to allow a number of separate data services to be multiplexed into a single DAB sub-channel. Carriage of simple stream data in such a channel is implemented by sending data *when there is data to send*.

In order to carry stream data in this very simple way, the data is sent without a beginning or an end. Thus, only one X-PAD application type is required for each User Application using the "Transparent Data Channel" (see EN 300 401 [1], clause 7.4.3) to identify the X-PAD data subfields carrying TDC data. The X-PAD application type used is signalled using FIG 0/13.

4.3.1.1 Using short X-PAD for the TDC

Table 2-4 shows the structure of short X-PAD but it should be noted that the byte order of the X-PAD fields is reversed on transmission. See EN 300 401 [1] for more details.

Table 2-4: Structure of X-PAD when using short X-PAD

Syntax	Size	Type	Value
<pre>X-PAD_field() { if (contents_indicator_flag == 1) { application_type X-PAD_subfield } else { X-PAD_subfield } }</pre>	8 bits 24 bits 32 bits	uimsbf uimsbf uimsbf	

contents_indicator_flag: This flag is identical with the CI flag in F-PAD (see EN 300 401 [1]) and is used to indicate the presence of a contents_indicator field in the same DAB audio frame.

application_type: This field determines the intended application for the X-PAD_subfield in conjunction with FIG 0/13.

X-PAD_subfield: This field carries the stream data for the TDC.

4.3.1.2 Using variable length X-PAD for the TDC

Table 2-5 shows the structure of variable length X-PAD but it should be noted that the byte order of the X-PAD fields is reversed on transmission. It also should be noted, that in addition to the table, a complete X-PAD field may comprise a single data subfield (provided the X-PAD field is containing a continuation of the X-PAD data application of the same type as that carried in the last X-PAD data subfield of the previous DAB audio frame). For details see EN 300 401 [1] and TR 101 496 [2].

Table 2-5: Structure of X-PAD when using variable length X-PAD

Syntax	Size	Type	Value
<pre> X-PAD_field() { if (contents_indicator_flag == 1) { for (i=0;i<N1;i++) { X-PAD_subfield_length application_type if (application_type == 31) { application_type_extension } } } for (i=0;i<N1;i++) { for (j=0;j<X-PAD_subfield_length(N1);j++) { X-PAD_data_byte } } } </pre>	 3 bits 5 bits 8 bits	 bslbf uimsbf uimsbf	

contents_indicator_flag: This flag is identical to the CI flag in F-PAD (see EN 300 401 [1]) and is used to indicate the presence of a contents_indicator field in the same DAB audio frame.

X-PAD_subfield_length: This field determines the length the X-PAD_subfield.

application_type: This field determines the intended application for the X-PAD_subfield in conjunction with FIG 0/13.

application_type_extension: This field determines the intended application for the X-PAD_subfield when the application type is set to 31.

X-PAD_data_byte: These fields carry the data for the X-PAD sub-field.

4.3.2 TDC in X-PAD with data groups

X-PAD uses a simple protocol to allow a number of separate data services to be multiplexed into a single DAB sub-channel. Carriage of simple stream data in such a channel is implemented by sending data *when there is data to send*.

In order to carry stream data, the data is put into MSC data groups, which in turn are sent in X-PAD data groups (see EN 300 401 [1], clause 7.4.5). Thus, two X-PAD application types (start and continuation) are required for each User Application using the "Transparent Data Channel" (see EN 300 401 [1], clause 7.4.3) to identify the X-PAD data subfields carrying TDC data. The X-PAD application types used are signalled using FIG 0/13.

The structure of the data group carrying TDC data is exactly the same as for "TDC in a packet mode service component with data groups" (see clause 4.1.2) and the data groups may be carried in either short X-PAD or variable length X-PAD.

5 Guidelines for the use of the Transparent Data Channel

Simple stream data formats are extremely common, not least because the bulk of Internet communication uses stream transport in the form of TCP/IP. When defining applications to use the DAB Transparent Data Channel, however, it is important to recognize that there are differences between streams implemented using TCP/IP and broadcast streams.

In TCP/IP, a series of acknowledgements and time-outs is used to detect and correct any errors that are introduced into the data for the stream. This means that reliable delivery of the data is guaranteed but this feature relies on the fact that the Internet allows bi-directional communication. In a broadcast environment there is no possibility for a receiver to request re-transmission of data that has been corrupted, and so it is not possible to guarantee reliable delivery of data using the DAB Transparent Data Channel.

Because reliable delivery of data cannot be assumed, applications that use the Transparent Data Channel for data transport **must ensure that they are tolerant to errors** in the data. This applies to corrupted data, loss of data and additional erroneous data.

The TDC specification is based on two mechanisms provided by EN 300 401 [1] for data delivery, either delivery in a packet mode service component or in an audio service component using X-PAD. So the specification enables each service provider to whom only one single type of service component is assigned by regulation authorities, to take the appropriate mechanism.

In case of an audio service component using X-PAD the TDC specification offers a single, but very simple delivery mechanism.

In case of a packet mode service component there are three options to be chosen from. Which of the options will be chosen has to be determined by the definition of the application, depending on its requirements in terms of performance and complexity, particularly in terms of storage capacity and error robustness. The options are:

- The TDC in a packet mode component without data groups is a very simple delivery mechanism, as simple as the TDC in an audio service component.
- If the TDC is using data groups in packet mode, but without any session header, TDC provides the possibility to retransmit the same data group one or several times, so that a receiver can cope with bit errors in one or the other data group. It is recommended that the data group is restricted to a size of 8 kBytes. This ensures, that under normal reception conditions the error probability for a data group can be kept low and that further on, the storage capacity is in line with a more advanced receiver design. The same restriction applies when a session header is used with end user address field only.
- If the TDC is used with data groups including session headers, it is capable to deliver "chunks" of data. As with a multimedia object (see MOT protocol - EN 301 234 [3]) a chunk is segmented in data groups of equal size. Each segment of a chunk is identified by its segment number. All segments of a particular chunk are identified by the same TransportId.

If an application uses the TDC delivery in packet mode, it should use the method with the lowest complexity that complies with the required performance.

The TDC delivery of chunks is included in the present document for completeness and with the intention to provide future proof mechanisms.

History

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