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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: 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 [7], 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: DAB is a registered trademark owned by one of the Eureka Project 147 partners.

1 Scope

The present document specifies the transport of IPDC services using the MSC stream mode of DAB (EN 300 401 [7]) including additional error protection (TS 102 427 [8]). IPDC services, e.g. audio and video services, are packetized and synchronized using RTP [15] and appropriate RTP payload format specifications. The present document specifies the mechanism for the multiplexing of the multimedia data using MPEG-2 TS [11]. For efficiency, some appropriate restrictions to MPEG-2 TS and an efficient transmission method for PSI/SI and SAT sections are specified. The present document also specifies methods of macro and micro time slicing for power-efficient transmission of IPDC Services in DAB systems. The methods for sub-channel synchronization and data arrangement are specified.

2 References

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.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
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    - for informative references.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

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

[2] ETSI TS 102 470: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Program Specific Information (PSI)/Service Information (SI)".

[3] ETSI TS 102 471: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Electronic Service Guide (ESG)".

[4] ETSI TS 102 474: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Service Purchase and Protection".

[5] ETSI TS 102 472: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Content Delivery Protocols".

[6] ETSI TS 102 005: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in DVB services delivered directly over IP protocols".

[7] ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[8] ETSI TS 102 427: "Digital Audio Broadcasting (DAB); Data Broadcasting - MPEG-2 TS streaming".

[9] ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

[10] ITU-R Recommendation BT.709: "Parameter values for the HDTV standards for production and international programme exchange".

[11] ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information - Part 1: Systems".

[12] ITU-T Recommendation H.264: "Advanced video coding for generic audiovisual services ".

[13] ISO/IEC 14496-10 (2005): "Information Technology - Coding of audio-visual objects - Part 10: Advanced Video Coding".

[14] ISO/IEC 14496-3: "Information technology - Coding of audio-visual objects - Part 3: Audio".

[15] IETF RFC 3550: "RTP, A Transport Protocol for Real Time Applications".

[16] IETF RFC 3926: "Flute - File Delivery over Unidirectional Transport".

[17] ETSI EN 301 192: "Digital Video Broadcasting (DVB); DVB specification for data broadcasting".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI TR 102 473: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Use Cases and Services".

[i.2] ETSI TR 102 469: "Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Architecture".

[i.3] ETSI TR 101 211: "Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

DAB IPDC Service: DAB Service transporting one or more IPDC Services

IPDC Service: offer from a service provider to which media content is related.

NOTE: The IPDC Service uses the MPEG Service for transport

MPEG Service: transport service for IPDC Services

NOTE: In DVB/MPEG Systems (ISO/IEC 13818-1 [11]) the normal understanding of an MPEG Service is an Audio and Video Service

3.2 Symbols

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

=	Assignment operator
!=	Relational operator: Not equal to

3.3 Abbreviations

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

A/V	Audio/Video
AAC	Advanced Audio Coding
ALC	Asynchronous Layered Coding
AV	Audio-Visual
bslbf	Bit string, left bit first.

NOTE: "Left" is the order in which bit strings are written in the present document. Bit strings are written as a string of 1s and 0s within single quote marks, e.g. '1000 0001'. Blanks within a bit string are for ease of reading and have no significance.

CAT	Conditional Access Table
CBMS	Convergence of Broadcast and Mobile Services
CIF	Common Interleaved Frame
COFDM	Coded Orthogonal Frequency Division Multiplex
CRC	Cyclic Redundancy Check
CU	Capacity Unit
DAB	Digital Audio Broadcasting
DMB	Digital Multimedia Broadcasting
DVB	Digital Video Broadcasting
DVB-H	DVB-Handheld
DVB-T	Digital Video Broadcasting - Terrestrial
EIT	Event Information Table
EPG	Electronic Programme Guide
ESG	Electronic Service Guide
ESM	Enhanced Stream Mode
FEC	Forward Error Correction
FIC	Fast Information Channel
FLUTE	File deLivery over Unidirectional Transport
H.264/AVC	H.264/Advanced Video Coding
HDTV	High Definition TeleVision
HE AAC	High-Efficiency Advanced Audio Coding
HTML	Hyper Text Markup Language
IEC	International Electrotechnical Commission
INT	IP Notification Table
IP	Internet Protocol
IPDC	IP Data Casting
ISO	International Organization for Standardization
LCT	Layered Coding Transport
MBMS	Multimedia Broadcast/Multicast Service
MPE	Multi Protocol Encapsulation
MPEG	Moving Pictures Experts Group
MPEG-2 TS	MPEG-2 Transport Stream
MPEG-2	MPEG Standard for Generic Coding of Moving Pictures and Associated Audio (ISO/IEC 13818)
MSC	Main Service Channel
NIT	Network Information Table
PAT	Programme Association Table
PCR	Programme Clock Reference
PID	Packet IDentifier
PMT	Programme Map Table

PNG	Portable Network Graphics
PSI	Programme Specific Information
PSNR	Peak Signal-to-Noise Ratio
RF	Radio Frequency
RS	Reed-Solomon
RTP	Real-time Transport Protocol
SAT	Sub-channel Assignment Table
SDP	Session Description Protocol
SDT	Service Description Table
SI	Service Information
SRTP	Secure Real-time Transport Protocol
TDT	Time and Date Table
TS	Transport Stream
TSDT	Transport Stream Description Table
UDP	User Datagram Protocol
uimsbf	Unsigned integer, most significant bit first

NOTE: The byte order of multi-byte words in the coded bit-stream is most significant byte first.

UMTS	Universal Mobile Telecommunications System
VBR	Variable Bit Rate
XML	Extensible Markup Language

4 General concept and structure

4.1 DAB IPDC system architecture

The idea of DAB IPDC is to transmit IP Datacast (IPDC) Services over DAB (EN 300 401[7]) taking into account the transport of IPDC over MBMS and DVB. For the transport the DAB IPDC Layer is defined which is placed on top of the MSC streaming mode of the DAB system. Figure 1 shows the DAB IPDC Layer in the context of different transmission systems.

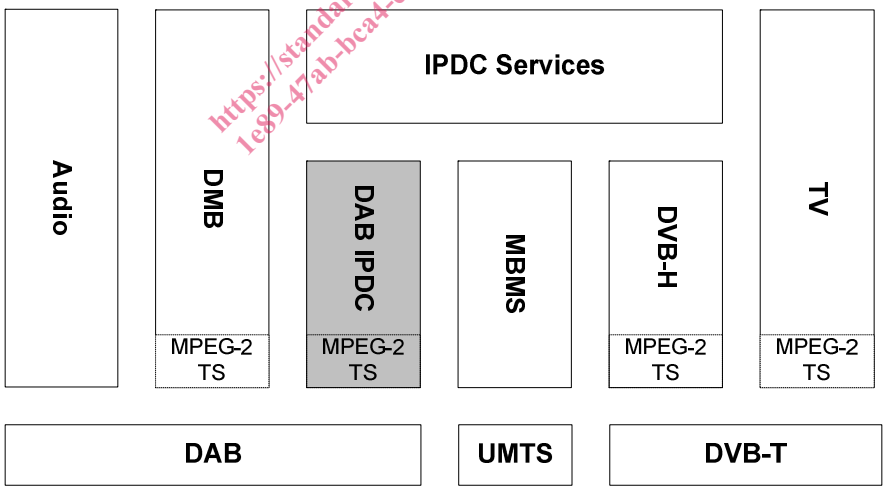

Figure 1: DAB IPDC in the context of other transmission systems

IP Datacast over DAB is an end-to-end broadcast system for delivery of any type of digital content using IP-based mechanisms optimized for devices with limitations on computational resources and battery. The most important DAB IPDC application is the efficient transport of multiple audiovisual services based on H.264/AVC video coding [12] & [13] using optional statistical multiplex and HE-AAC audio coding [14].

The IPDC Architecture used in DAB is aligned to the specifications of IPDC from the DVB-CBMS (Convergence of Broadcast and Mobile Services) working group. IPDC includes the specification of:

- Usage of PSI/SI
- Elementary Use Cases
- Reference Architecture for IPDC Service Delivery
- Electronic Service Guide (ESG)
- Service Purchase and Protection (SPP)
- Content Delivery Protocols (CDP)

A detailed description of mandatory IPDC documents is given in clause 5.1.

4.2 DAB IPDC protocol stack

The DAB IPDC protocol stack differs only in the bottom layer from the protocol stack which is used for DVB-H. In Figure 2 the respective protocol stacks are shown, the only difference is the transport of the MPEG-2 TS over DAB instead of DVB-H. The usage of every layer is covered by existing specifications and equivalent layers will be handled in the same way for DAB IPDC as for DVB-H. The transport of the MPEG-TS in DAB is based on TS 102 427 [8] in a flexible and power efficient way, which is specified in this clause.

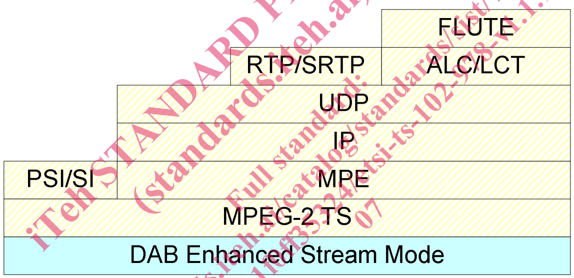

Figure 2: DAB IPDC Protocol Stack

4.3 IPDC data packet transport over DAB

In IPDC, the payload consists of IP packets, which are used to carry streaming data as well as file carousels. IP datagrams are encapsulated into MPE sections, which in turn are carried in MPEG-2 TS packets. A comprehensive overview of this structure is given in TS 102 470 [2],clause 4.3.

MPEG-2 TS packets carrying MPE sections containing IP datagrams with multiple IP addresses may be carried in a single DVB service component, i.e. they may share a single PID. To improve the power efficiency of the DAB IPDC system, it is recommended to group only such IP streams into one PID which are required for consuming a single service.

The data rate assigned for a single PID is not fixed within an MPEG-2 TS. This allows statistical multiplexing between services, provided that the overall data rate of the transport stream does not exceed a given limit determined by the DAB multiplex.

Figure 3 depicts the mapping from AV sources to a single MPEG-2 TS. A number of AV sources is encoded using a common statistical multiplexing control, which assigns the data rates to the encoders of the sources. The output of the encoders is a set of IP streams with varying bandwidth demands. However the sum bandwidth requirement remains constant.

The result of the subsequent IP encapsulation (MPE) is an MPEG-2 TS with a series of TS packets.

NOTE: For DAB IPDC services the MPE-FEC option of MPE is not active (code rate R=1) as an equivalent forward error protection is provided by the DAB Enhanced Stream Mode (see figure 5).

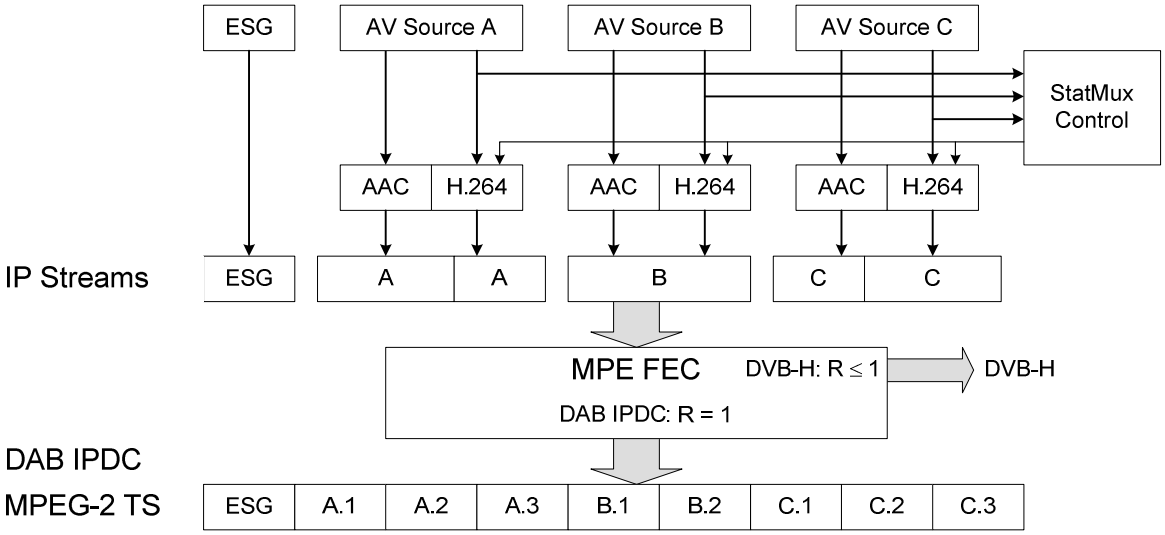

Figure 3: Mapping of IPDC Services into MPEG-2 Transport stream

4.4 DAB IPDC data transport mechanism

The DAB IPDC data transport mechanism enables DAB power saving modes at the presence of variable bit rate (VBR) services. The general idea is to split the incoming MPEG-2 transport stream over multiple sub-channels which allows selective decoding of only the required sub-channels for the currently active application in the receiver. The granularity of the power saving is defined by the number of sub-channels used by the DAB IPDC Service.

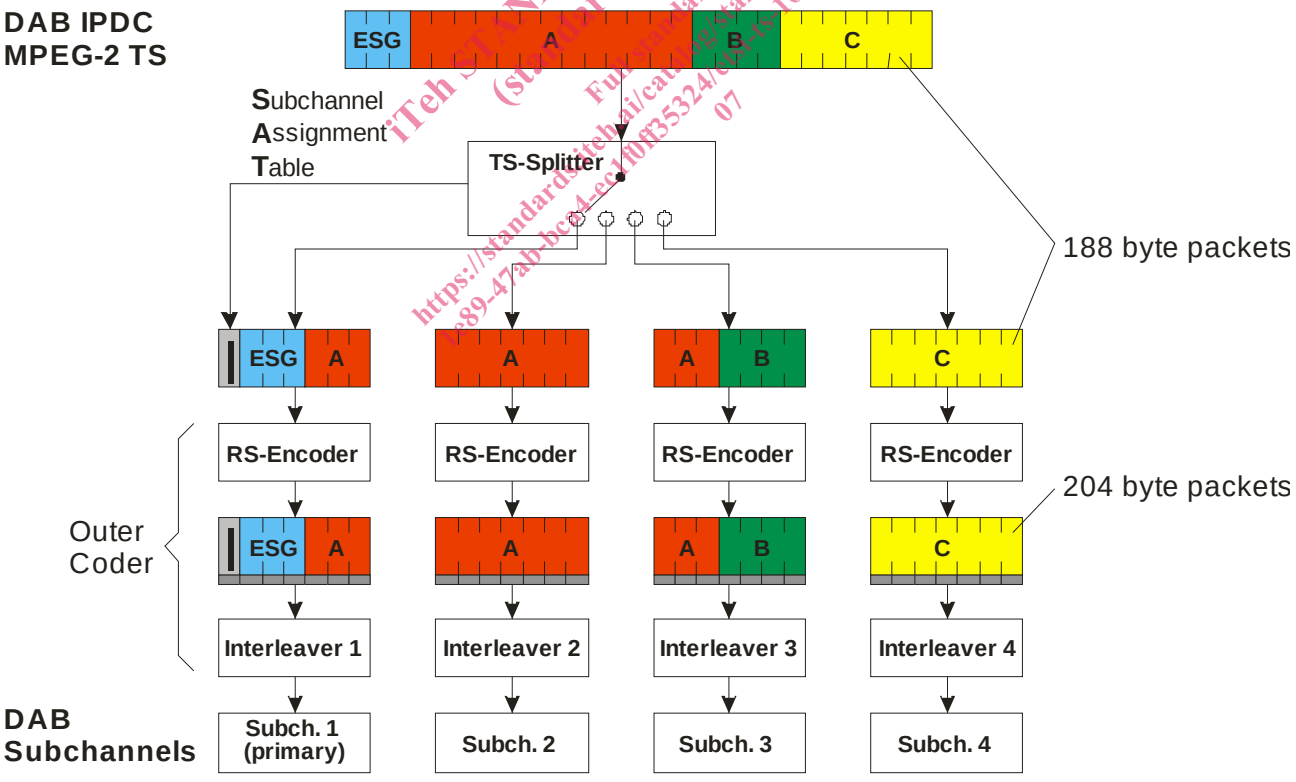

Figure 4: DAB IPDC transport mechanism for MPEG-2 transport streams