

Digital Video Broadcasting (DVB); Guidelines for the handling of Asynchronous Transfer Mode (ATM) signals in DVB systems

European Broadcasting Union



Union Européenne de Radio-Télévision

DVB
Digital Video
Broadcasting



Reference

DTR/JTC-DVB-30 (7jo00ics.PDF)

Keywords

ATM, broadcasting, digital, DVB, TV, video

ETSI

Postal address

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet

secretariat@etsi.fr
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Foreword

This Technical Report (TR) has been produced by the 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.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

Digital Video Broadcasting (DVB) Project

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

1 Scope

The present document provides the mapping scheme to be used for the transport of ATM cells over MPEG-2 Transport Stream packets.

The purpose of encapsulating ATM cells directly into an MPEG-2 transport stream is to:

- interconnect ATM networks via DVB systems or provide ATM services to end-users using DVB systems;
- offer differentiated quality of service to end-users by utilizing the ATM mechanisms.

The main constraints of this problem are to:

- providing an efficient encapsulation mechanism;
- maintaining DVB/MPEG-2 compatibility when transporting ATM cells;
- respecting ATM Quality-of-Service requirements throughout DVB/MPEG systems.

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.
- 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] AF-PHY-0017.000: "The ATM Forum Technical Committee, UTOPIA Specification, Level 1, Version 2.01".
- [2] EN 301 192: "Digital Video Broadcasting (DVB); DVB specification for data broadcasting".
- [3] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".
- [4] ITU-T Recommendation I.356: "B-ISDN ATM layer cell transfer performance".
- [5] ITU-T Recommendation I.371: "Traffic control and congestion control in B-ISDN".
- [6] ITU-T Recommendation I.432.1: "B-ISDN user-network interface - Physical layer specifications: General characteristics".
- [7] ITU-T Recommendation I.432.2: "B-ISDN user-network interface - Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation".
- [8] ITU-T Recommendation I.610: "B-ISDN Operation and maintenance principles and functions".
- [9] ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information: Systems".

3 Abbreviations and definitions

3.1 Abbreviations

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

ATM	Asynchronous Transfer Mode
CDV	Cell Delay Variation
CEC	Cell Error Control
CRC	Cyclic Redundancy Check
EDC	Error Detection Code
HEC	Header Error Control
LOC	Loss Of Cell delineation
LOS	Loss Of Signal
MPEG-TS	MPEG Transport Stream
OAM	Operation, Administration and Maintenance
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Packet Identifier
PL	Physical Layer
QoS	Quality of Service
RDI	Remote Defect Indication
REB	Remote Errored Blocks
SAR	Segmentation And Re-assembly
TS	Transport Stream
VBR	Variable Bit Rate
VC	Virtual Channel
VP	Virtual Path

3.2 Definitions

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

idle cell: a cell which is inserted and extracted by the physical layer in order to adapt the cell flow rate at the boundary between the ATM layer and the physical layer to the available payload capacity of the transmission used.

valid cell: a cell whose header has no errors or has been modified by the cell Header Error Control (HEC) verification process.

4 System description

The standard DVB/MPEG system defines all functionality's for encoding video and audio into MPEG Transport Streams (TSs), which are then multiplexed, along with data, into a single Transport Stream. This multiplex is modulated for transmission over the network. At the receiver side, the demodulator outputs the multiplex to a Transport Stream demultiplexer which extracts individual streams.

The goal of this guideline is to give recommendations on carrying native ATM services using the standard DVB/MPEG system.

Figure 1 shows an end-to-end DVB/MPEG conceptual block diagram, where additional blocks have been added to insert ATM cells into the system and extract ATM cells at the user side.

The 188 bytes (4 bytes header) MPEG transport packet is part of the data link sublayer defined to carry MPEG-2 video, audio, and data streams in DVB systems. A segmentation and re-assembly mechanism is needed to segment each information stream into MPEG-TS packets. Different schemes are presently defined in the MPEG standard ISO/IEC 13818-1 [9] and the DVB data broadcasting standard EN 301 192 [2]. In the MPEG standard ISO/IEC 13818-1 [9], the Packetized Elementary Stream (PES) and the Private Section are defined. For PES, MPEG defines an Adaptation Field mechanism which provides a technique to stuff MPEG-TS packets with stuffing bytes when transmit buffers are empty. For Private Sections, MPEG only defines a minimum structure. DVB specifies a format for the Private Sections in order to carry Multi-Protocol Encapsulation which can transport any type of Network Layer traffic. Also, another scheme defined by DVB is called data piping, consists in putting the raw traffic directly over MPEG-TS packets without any extra overhead.

In ATM, the typical data link layer is composed of 53 bytes cells (5 bytes header) and is using its own segmentation and re-assembly mechanism (AAL). Usually, ATM cells are transported directly over a physical medium, which has its own transmission mechanism. Although ATM cells are asynchronous by nature, they are usually transmitted over the physical medium of a synchronous hierarchy network. Transmit and Receive buffers take care of following the constraints defined by ITU-T Recommendation I.356 [4].

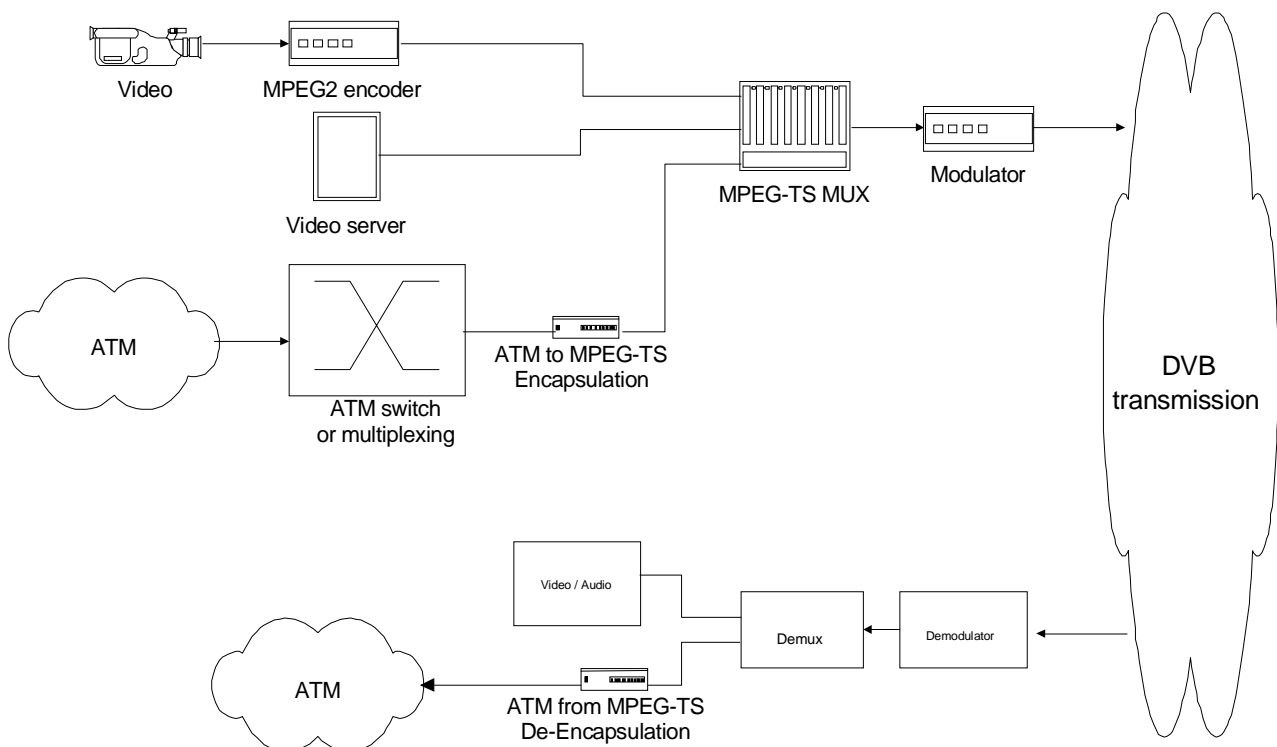


Figure 1: Conceptual DVB/MPEG chain carrying ATM

5 Mapping of ATM cells into DVB/MPEG-2 Transport Stream

5.1 Frame format

The basic MPEG-TS packet structure of 188 octets as described in ISO/IEC 13818-1 [9] shall be used. The ATM cells are mapped into the 184 payload octets of the TS packet with the octet structure of the cell aligned with the octet structure of the packet. The data piping mechanism described in EN 301 192 [2] shall be used to transport ATM cells in MPEG-TS packets. The 53 bytes ATM valid cells are consecutively inserted into the 184 bytes payload of the MPEG-TS packets.

When valid cells are not available from the ATM layer, the mechanism described in subclause 5.2 shall be used.

5.2 Cell rate adaptation

The cell rate adaptation to the payload capacity of the MPEG-TS packets is performed either (i) by the insertion of idle cells, as described in ITU-T Recommendation I.432-1 [6] (see Figure 2), or (ii) by using the MPEG-TS adaptation fields mechanism, as described in ISO/IEC 13818-1 [9] (see Figure 3). A combination of these two mechanisms is possible.

The start of an idle cell at the end of an MPEG-TS packet shall be completed at the beginning of the next packet with the same PID. The MPEG adaptation fields mechanism allows that the next MPEG-TS packet can start immediately with a new valid cell, if available.

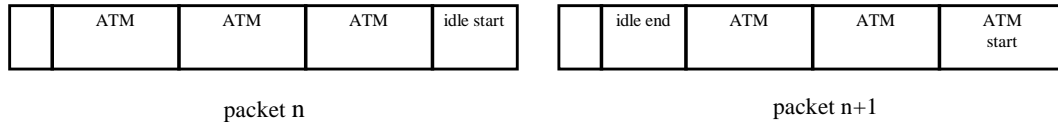


Figure 2: Idle cells inserted into the stream

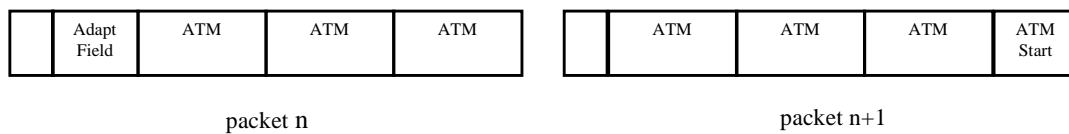


Figure 3: Adaptation fields inserted into the MPEG-TS header

When no valid cell is available from the ATM layer during the transmission of a full MPEG-TS packet, either (i) the MPEG-TS packet is transmitted filled up with idle cells, or (ii) a NULL MPEG-TS packet is sent to the transport multiplexer.

5.3 Header Error Control (HEC) generation

The HEC value is generated and inserted in the specific field in compliance with ITU-T Recommendation I.432.1 [6].

5.4 Scrambling of the ATM cell payload

The ATM cell payload (48 bytes) shall be scrambled before mapping into the MPEG-TS. In the reverse operation, following termination of the MPEG-TS, the ATM cell payload will be descrambled before being passed to the ATM layer. A self-synchronizing scrambler with the generator polynomial $x^{43} + 1$, as described in ITU-T Recommendation I.432.1 [6], shall be used. Cell payload field scrambling is required to provide security against false cell delineation and replication of the MPEG-TS packets synchronization.

5.5 Cell delineation

The cell delineation shall be performed using the Header Error Control (HEC) mechanism as defined in ITU-T Recommendation I.432.1 [6]. The mechanism for the detection of loss and recovery of cell delineation shall follow the description given in subclause 8.2.2 of ITU-T Recommendation I.432.2 [7]. Loss Of Cell delineation (LOC) causes a LCD defect.

5.6 Cell header verification and extraction

The cell header verification shall be performed in compliance with ITU-T Recommendation I.432.1 [6]. All the physical layer cells shall be extracted and only the valid cells are passed to the ATM layer. Idle cells are discarded.

5.7 Physical layer Operation And Maintenance (OAM)

OAM flows defined in ITU-T Recommendation I.610 [8] for ATM shall be transmitted along with traffic flows according to the present document. F1-F3 are physical layer related OAM flows, whereas F4-F5 flows are ATM layer related and are carried using ATM cells with a specific VCI.

In order to avoid specific definitions in the MPEG-TS for ATM maintenance, F1 and F3 flows shall be carried in maintenance cells (PL-OAM) using a specific pattern in the header as defined for cell based transmission systems. The ATM cell header and the allocation of OAM functions in the information field of these special ATM cells shall follow the description given in subclause 7.2.2 of ITU-T Recommendation I.432.2 [7]. These cells are not passed to the ATM layer. F2 flow is not provided, but the associated functions are supported by F3 flows. Each MPEG stream shall carry its own F1-F3 flows.

Maximum spacing between PL-OAM cells:

The spacing between two adjacent PL-OAM cells is 216 cells using the block boundaries as described in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7]. This interval consists of 8 monitored blocks with each block containing 27 cells.

5.7.1 Signal processing for PL-OAM cells in the transmitter

a) Continuity Counter

This function shall include for F1 and F3 flows, respectively, a continuous sequence number into the PSN field according to subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7].

b) Error Detection Code (EDC)

This function shall calculate an EDC according to subclause 7.2.2.3 ITU-T Recommendation I.432.2 [7]. The result of this calculation is included into the appropriate EDC fields of the actual PL-OAM cell.

c) Remote Errored Blocks (REB)

This function performs the remote error control of the far end system as described in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7] by using the contents of the REB field of the PL-OAM cell.

NOTE 1: In case of unidirectional transmission, there is no associated receiving path termination and the REB field shall be set to a logical "0".

d) Cell Error Control (CEC)

This function shall perform a CRC calculation of the actual PL-OAM cell as described in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7].

e) Transmission path alarm indication

This function is only used in the F3 OAM cells in order to alert the equipment in the direction of transmission that a failure has been detected. The function shall follow the specification given in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7].

f) Remote Defect Indication (RDI)

If one of the defects described in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7] are detected in the downstream path, the appropriate bits of the RS-RDI/TP-RDI field are set in order to alert the upstream equipment in the opposite direction of transmission that a defect has been detected along the downstream path.

NOTE 2: In case of unidirectional transmission, there is no associated receiving path termination and the RDI field shall be set to a logical "0".

5.7.2 Signal processing for PL-OAM cells in the receiver

a) Continuity Check

For each type (F1 and F3) of PL-OAM cell, this function checks the correct spacing between two adjacent PL-OAM cells according to subclause 8.2.1 of ITU-T Recommendation I.432.2 [7].

b) Error Detection

This function computes the EDC of the monitored interval according to subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7] and compares the result with the recovered values of the EDC field of the appropriate PL-OAM cell. A difference between the computed value and the recovered value is taken as evidence of one or more errors having occurred in the specified block.

c) Cell Error Control (CEC)

This function computes a CRC calculation of the actual PL-OAM cell as described in subclause 7.2.2.3 of ITU-T Recommendation I.432.2 [7] and compares its result with the recovered values of the CEC field of the PL-OAM cell. A difference between the computed value and the recovered value is taken as evidence of one or more errors having occurred in the actual PL-OAM cell.

d) Remote Defect Indication (RDI)

In order to enable single ended maintenance of a bi-directional transmission, the remote defect indication is recovered from the RS-RDI/TP-RDI field.

NOTE: In case of unidirectional transmission, the contents of the RS-RDI/TP-RDI field is ignored.

e) Loss Of Signal (LOS)

The criteria for detection and clearance of LOS are given in subclause 8.2.1 of ITU-T Recommendation I.432.2 [7].

f) Performance monitoring

This function shall generate performance parameters according to the specification given in annex D of ITU-T Recommendation G.826 [3].

6 Implementation aspects

6.1 ATM to MPEG-TS gateway and MPEG-TS multiplexer

The MPEG-TS multiplexers usually have the possibility to reserve a constant bandwidth for a given stream. They do not have to maintain a fixed amount of time between successive MPEG-TS packets of the same PID, since the PCR mechanism is used at the receiver to recover synchronization. Yet, ATM traffic is asynchronous, and presents additional Quality of Service (QoS) constraints such as Cell Delay Variation (CDV), which shall be taken into account when transmitting it over a non perfectly synchronous MPEG-TS stream.

ITU-T Recommendations I.356 [4] and I.371 [5] shall be followed to measure CDV over DVB/MPEG systems, and *traffic shaping algorithms at the ATM to MPEG-TS gateway* may need to be implemented, especially if a lot of Variable Bit Rate (VBR) connections are set up. Also, if the amount of time between successive MPEG-TS packets varies too much through time, the CDV tolerance may be exceeded. Therefore, it is important to try to *respect the most periodic distribution of the MPEG-TS packets carrying ATM cells* in the MPEG-TS multiplexer, as shown in Figure 4.

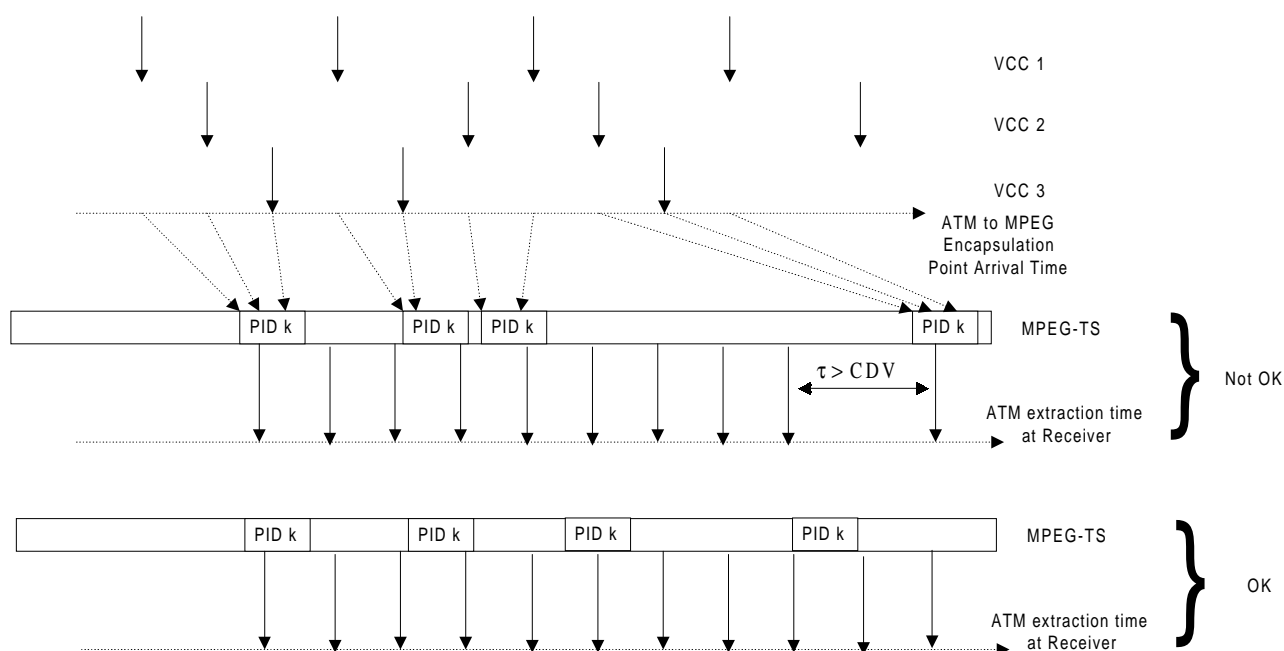


Figure 4: MPEG-TS packets distribution for ATM traffic support

6.2 MPEG-TS demultiplexer

The MPEG-TS demultiplexer may output directly ATM cells on a hardware interface such as the UTOPIA interface [1], in order to interface with other standard Segmentation And Re-assembly (SAR) devices for AAL layer processing. A separate ATM extraction device can also be placed after standard transport demultiplexers in order to extract ATM cells according to the present document.

7 Conditional Access

Conditional Access may be implemented at the MPEG-TS level or at the ATM level, or at both. When applied at the MPEG-TS level, the entire stream is scrambled, but individual VP/VCs may not be independently scrambled. When applied at the ATM level, each VP/VC may be individually scrambled.

History

Document history		
V1.1.1	February 1999	Publication