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TRANSMISSION OF SOUND-PROGRAMME AND TELEVISION SIGNALS

TRANSPORT OF MPEG-2 CONSTANT BIT RATE TELEVISION SIGNALS IN B-ISDN

ITU-T Recommendation J.82

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation J.82 was prepared by ITU-T Study Group 9 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 11th of July 1996.

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SUMMARY

This Recommendation addresses the transport of television signals in ATM, in the case where they are MPEG-2 coded with a constant bit rate. It recommends the utilization of the AAL type 1 with the convergence sublayer for the transport of video signals, or the utilization of the AAL type 5.

INTRODUCTION

A growing interest is currently being shown in the television community for the transport of digital television programmes in the Broadband Integrated Services Digital Network (B-ISDN). Reasons for this are twofold:

–   From the application point of view, coding techniques for television signals have reached maturity, with the MPEG-2 standard (ITU-T Rec. H.222.0 | ISO/IEC 13818-1) increasingly recognized as the basic standard for coding of television signals.

–   From the network point of view, the Asynchronous Transfer Mode (ATM) has been recommended as the basic technique of B-ISDNs, providing the flexibility which future applications will need. Moreover, ITU-T Recommendations on B-ISDN have attained a high degree of stability and are near completion.

The transport of television programmes in B-ISDN will undoubtedly be a useful service for carriers as well as for service providers. As initial ATM networks are currently under installation, the need to specify guidelines for the transport of MPEG-2 coded television signals in B-ISDN is recognized as urgent by standardization bodies.

TRANSPORT OF MPEG-2 CONSTANT BIT RATE TELEVISION SIGNALS IN B-ISDN

(Geneva, 1996)

1 Scope

The scope of this Recommendation covers the transport of television signals in Broadband-ISDN. In the context of this Recommendation television signals are encoded and transmitted in compliance with MPEG-2 systems specified in ITU-T Rec. H.222.0 | ISO/IEC 13818-1, with a constant bit rate.

Broadband-ISDN is based on the Asynchronous Transfer Mode (ATM) (see Recommendation I.121). Other ITU-T Recommendations which apply are those of the I-Series concerning ATM.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

–   ITU-T Recommendation H.222.0 (1995) | ISO/IEC 13818-1:1996, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.

–   CCITT Recommendation I.121 (1991), *Broadband aspects of ISDN*.

–   ITU-T Recommendation I.150 (1993), *B-ISDN asynchronous transfer mode functional characteristics*.

–   ITU-T Recommendation I.361 (1993), *B-ISDN ATM layer specification*.

–   ITU-T Recommendation I.362 (1993), *B-ISDN ATM adaptation layer (AAL) functional description*.

–   ITU-T Recommendation I.363.1 [1]), *B-ISDN ATM Adaptation Layer specification: Types 1 and 2 AAL*.

–   ITU-T Recommendation I.363.5 [1]), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*.

–   ITU-T Recommendation Q.2931 (1995), *Broadband Integrated Services Digital Network (B-ISDN) – Digital Subscriber Signalling No. 2 (DSS 2) – User-Network Interface (UNI) layer 3 specification for basic call/connection control*.

3 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

AAL   ATM Adaptation Layer

ATM   Asynchronous Transfer Mode

CBR   Constant Bit Rate

CDV   Cell Delay Variation

CLP   Cell Loss Priority

CPCS   Common Part Convergence Sublayer

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[1]) Presently at the stage of draft.

CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
CSI	Convergence Sublayer Indication
FEC	Forward Error Correction
IDU	Interface Data Unit
MPEG	Moving Pictures Expert Group
PCR	Programme Clock Reference
PDU	Protocol Data Unit
QOS	Quality of Service
RS	Reed Solomon
SAP	Service Access Point
SAR	Segmentation and Reassembly sublayer
SC	Sequence Count
SDU	Service Data Unit
SSCS	Service Specific Convergence Sublayer
TS	Transport Stream

4 Application aspects

This Recommendation concerns MPEG-2 coded television signals. It takes into consideration the case where signals are coded with a constant bit rate. This is a mandatory requirement for this Recommendation to apply.

MPEG-2 signals are assumed to be coded in the form of a "Transport Stream" as it is defined in Recommendation H.222.0, since, as mentioned in that Recommendation, the "Transport Stream is designed for use in environments where errors are likely, such as storage or transmission in lossy or noisy media". However, the presentation of signals in the form of the Transport Stream is not mandatory.

As specified in Recommendation H.222.0, the MPEG-2 Transport Stream (TS) is organized in fixed-length packets sized to 188 octets.

5 Service aspects

Recommendation I.362 gives a classification of services based on the attributes of the timing relationship between source and destination, bit rate and connection mode. In particular, Recommendation I.362 states that Class A services have the following attributes:

– timing relationship between source and destination required;

– constant bit rate;

– connection-oriented mode.

The transport of television signals can have the attributes corresponding to those of Class A, so the transport of television signals may be considered as a Class A service in relation to B-ISDN. In addition, in Recommendation I.362, examples given for Class A services include constant bit rate video. Recommendation I.362 also gives the relationship between service classes and AAL types. In Recommendation I.362, it is stated that the provision of constant bit rate services can utilize the AAL type 1.

It should be noted that the MPEG-2 TS has means [Programme Clock Reference (PCR)] to recover the clock of the transmitting AAL user. As a result, MPEG-2 coded television signals can also be transported using the AAL type 5 when connections are assigned an appropriate QOS.

The Cell Delay Variation (CDV) at the ATM-SAP depends on the network size, the volume and the characteristics of accommodated traffic, among other factors. It is assumed that the CDV value may be in the order of about 1-3 ms for CBR traffic. If, for example, the H.222.0 decoder implementation can only accept CDV less than the above value at its input, and if the CDV has not been compensated for at the AAL-SAP, then Network Adaptation (see Figure 1) should provide the necessary CDV reduction. The method to reduce the CDV in the Network Adaptation function, if required, is implementation specific.
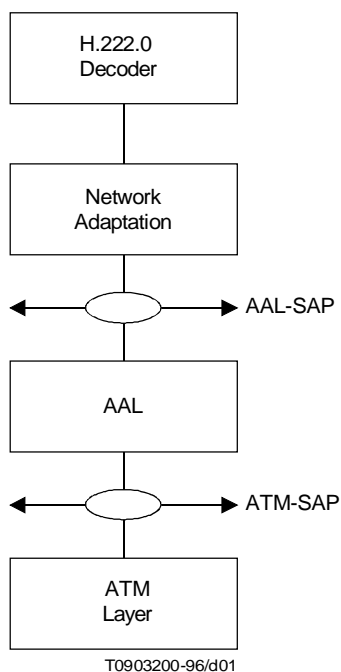

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FIGURE 1/J.82

The submitted Cell Loss Priority parameter (CLP) is set to high priority. The CLP bit is defined in Recommendation I.361 and its usage for constant bit rate services is addressed in Recommendation I.150.

6 Specification of the recommended AALs

Basically, the aim of the AAL is to enhance the quality of service provided by the ATM layer in order to fulfill service requirements. For the distribution of television signals, in addition to real-time requirements, it may be necessary to improve robustness to cell loss. If not countered, cell loss events might lead to unacceptable artifacts for the users. Therefore the AAL used for the transport of television signals may have to provide cell loss correction capabilities.

The AAL type 1 and the AAL type 5 are specified in Recommendations I.363.1 and I.363.5. In the description of the AAL type 1, four Convergence Sublayers (CSs) have been defined. In particular, a CS is dedicated to the transport of video signals. This CS is appropriate for the transport of television signals.

The AAL type 1 can be used for all MPEG-2 CBR coded video applications. The AAL type 5 can be used for MPEG-2 CBR coded video applications having less stringent QOS requirements. The AAL type 5 may require some functions to be performed in higher layers to compensate for a lower QOS at the AAL-SAP.

7 Functions of the AAL type 1 for MPEG-2 transport

The size of the MPEG-2 TS packets has been specified in relation to the SAR-PDU payload of the AAL type 1, i.e. 47 octets. As a result, a TS packet matches exactly four SAR-PDU payloads when the AAL type 1 is used.

Functions and protocols of the AAL type 1 to be used are those described in Recommendation I.363.1. Functions of the CS for the transport of video signals are described in Recommendation I.363.1. These functions are listed in detail below.

7.1 Handling of AAL user information

The length of the AAL-Service Data Unit (AAL-SDU) is one octet.

At the AAL-SAP (AAL-Service Access Point), the "Structure" parameter is not used.

The "Status" parameter is used in the receiving AAL-SAP whenever data is judged to be errored, thus permitting adequate counteractions in higher layers, for example to set the "transport error indicator" bit in the TS packet layer.

7.2 Handling of Cell Delay Variation (CDV)

It is mandatory to perform this function in order to keep residual CDV values at the AAL-Service Access Point (AAL-SAP) within limits compatible with specifications concerning MPEG-2 time stamps in Recommendation H.222.0. A buffer is used to perform this function. In the event of buffer underflow, it is mandatory for the CS to maintain bit count integrity by inserting the appropriate number of dummy bits. In the event of buffer overflow, it is mandatory for the CS to maintain bit count integrity by dropping the appropriate number of dummy bits.

7.3 Handling of lost and misinserted cells

Detection of lost and misinserted cell events in the AAL type 1 is performed by using a 3-bit Sequence Count (SC) enabling detection of up to six consecutive cell loss occurrences and of one misinserted cell occurrence. The CS processing for SC operations is described in Recommendation I.363.1.

7.4 Handling of the timing relationship

In order to provide a timing relationship between the source and destination, end-to-end synchronization is required. The method to be used is the adaptive clock method described in Recommendation I.363.1. This method is appropriate because it is not necessary in the case of the transport of video programmes to comply with the wander specifications of Recommendation G.823. Furthermore, the adaptive clock method does not rely on the availability of an external reference clock.

7.5 Correction of bit errors and lost cells

In the CS for video transport described in Recommendation I.363.1, a method based on Forward Error Correction (FEC) is proposed optionally for unidirectional video transport. This method relies on a combination of Reed Solomon (RS) codes and octet interleaving: the size of the interleaver is 128 SAR-PDU payloads (i.e. 128×47 octets, called the CS-PDU), whereas RS (128 and 124) codes are used.

This method shall be used for correction of bit errors and lost cells in the case of the transport of video programmes in ATM.

Correction capabilities are up to four cell losses (consecutive or not) in a group of 128 cells, and up to two errored octets in a block of 128 octets. As specified in Recommendation I.363.1, the use of the erasure mode is mandatory.

In the case where uncorrected errors have been detected, the "Status" parameter is used at the AAL-SAP to inform higher layers, as stated in 7.1 above.

The CS-PDU structure is synchronized by the Convergence Sublayer Indication (CSI) bit which is set to "1" for the first SAR-PDU payload of the CS-PDU.

The processing delay depends on the bit rate and corresponds to a duration of $124 \times 47 \times 2$ octets (at the AAL-SAP).

Furthermore, the beginning of the interleaver corresponds to the beginning of a TS packet (the interleaver contains exactly 31 TS packets).

8 Functions of the AAL type 5 for MPEG-2 transport

Functions and protocols of the AAL type 5 to be used are those described in Recommendation I.363.5. Both the SAR and the CPCS are used. The SSCS is null.

The MPEG-2 TS packets are mapped into the AAL type 5. In the mapping, 1 to N MPEG-2 TS packets are mapped into the AAL type 5 SDU, where N is an integer. Padding may be needed in order to meet this requirement. This mapping is referred to as the "1 to N" mapping.

The value of N is 2 unless a different value is established by signalling, specified in Recommendation Q.2931, at call set-up for switched calls or by provisioning information for non-switched calls.

The mapping is specified as follows:

1) Each AAL type 5-SDU shall contain N MPEG-2 TS packets, unless there are fewer than N packets remaining in the Transport Stream. In the case in which there are fewer than N packets left in the TS, the final CPCS-SDU contains all remaining packets.

2) In order to insure a base level of interoperability, all equipment must support at least the value N = 2 (Maximum CPCS-SDU size = 376 octets).

3) When the value N is established by signalling (using the AAL5 Maximum CPCS-SDU negotiation procedures of Recommendation Q.2931) or by provisioning, the AAL type 5 Maximum CPCS-SDU size is $N \times 188$ octets. N is an integer. The default CPCS-SDU size is 376 octets, which is two TS packets (N = 2).

Figure 2 illustrates the 1 to N mapping scheme for the case in which two TS packets are mapped into the AAL type 5 SDU (N = 2).

For the transport of MPEG-2 with the AAL type 5, the message mode service is used.

8.1 Handling of AAL user information

The AAL-SDU is passed across the CPCS interface in exactly one CPCS-IDU. When optionally delivering corrupted data to the CPCS user, an error indication is associated with the delivery.

8.2 Handling of Cell Delay Variation (CDV)

The AAL type 5 does not compensate for CDV. If this function is needed, layers above the AAL must provide appropriate compensation.

8.3 Handling of bit errors, lost cells and misinserted cells

The detection of errored bits is provided by the CRC-32 field of the CPCS-PDU trailer. The detection of lost and misinserted cells is provided in the CPCS by the Length field. Via the CRC and a comparison of the number of octets received with the indicated length, the AAL type 5 may be able to determine the loss of cells. Every AAL type 5 receive entity must be able to discard the AAL-SDU if an error is detected. In addition, some implementations may support the optional delivery of corrupted AAL-SDUs to the user with an indication of any errors detected. This is a local option.

8.4 Handling of the timing relationship

To be provided, if necessary, by layers above the AAL.

8.5 Correction of bit errors and lost cells

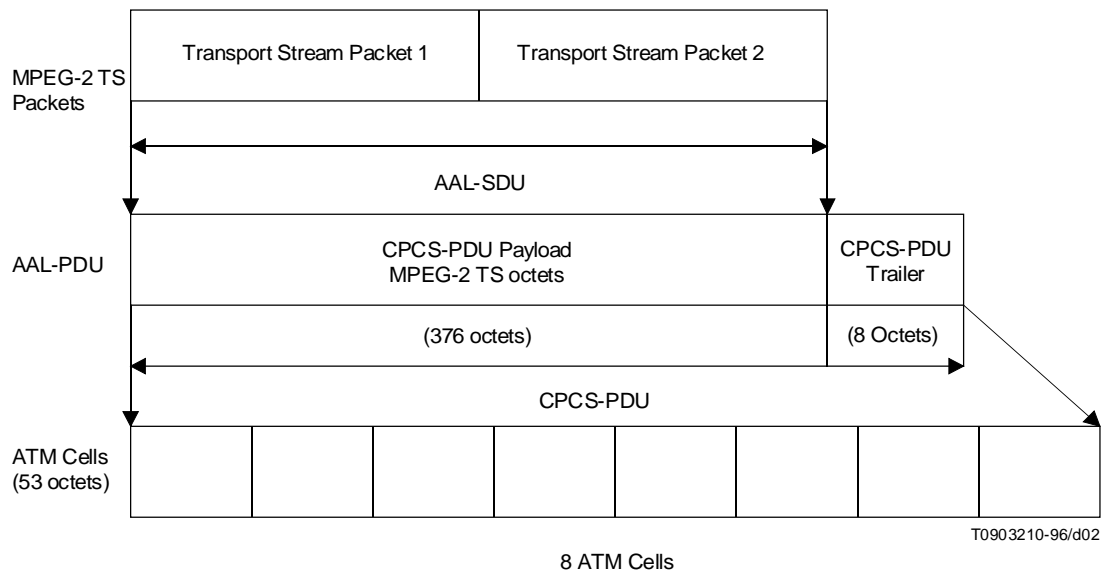The AAL type 5 does not provide this type of functionality.

FIGURE 2/J.82

1 to N mapping of MPEG-2 TS packets into AAL type 5 when N = 2