INTERNATIONAL TELECOMMUNICATION UNION

ITU-T J.183

(03/2001)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

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Time-division multiplexing of multiple MPEG-2 transport streams over cable television systems

ITU-T Recommendation J.183

(Formerly CCITT Recommendation)

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ITU-T Recommendation J.183

Time-division multiplexing of multiple MPEG-2 transport streams over cable television systems

Summary

This Recommendation describes a time-division multiplexing (TDM) format for transmission of multiple MPEG-2 transport streams using a simple implementation on cable television systems. The TDM frame encapsulates the MPEG-2 transport streams prior to transmission.

The format features interoperability with the existing conventional satellite transmodulation format, which is designed based on the specification of Annex C/J.83 and Annex C/J.84 (SMATV system C(III)).

This format may be applicable to other transmission systems. Information about the frame format should be transmitted in the network information table simultaneously, when this format is introduced into the existing digital cable television systems. It is needed for the set-top box to identify the digital channel containing multiple MPEG-2 transport streams.

Source

ITU-T Recommendation J.183 was prepared by ITU-T Study Group 9 (2001-2004) and approved under the WTSA Resolution 1 procedure on 9 March 2001.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation J.183

Time-division multiplexing of multiple MPEG-2 transport streams over cable television systems

1 Scope

The scope of this Recommendation is the definition of a time-division multiplexing frame format to adapt the multiple MPEG-2 transport streams into the existing physical layer interface specified in Annex C/J.83. This format may be applicable to other transmission systems.

The frame aims to multiplex transport streams without change except that some of the service information (SI) related to the network are replaced. By using this frame structure as an option to the conventional digital transmission equipment, multiple transport streams can be multiplexed as they are. The functionality of multiplexing transport streams into a single transport stream is not needed.

Implementation of this frame format enables the cable television operator to pack multiple transport streams in a single channel. Also, the flexibility on operation of cable distribution network would be obtained if the integration of services could be achieved by the transport stream basis.

This Recommendation provides the information needed by the designers and manufacturers of equipment (including receivers) for digital multi-programme signals distributed by cable networks.

2 References

2.1 Normative references

The following ITU-T 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; 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 H.222.0 (2000) | ISO/IEC 13818-1:2000, *Information technology – Generic coding of moving pictures and associated audio information: systems*.

– ITU-T J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.

– ITU-T J.84 (1997), *Distribution of digital multi-programme signals for television, sound and data services thorough SMATV networks*.

– ITU-T J.94 (1998), *Service information for digital broadcasting in cable television systems*.

2.2 Informative references

– JCTEA STD-002-2.0, Multiplexing System for Digital Cable Television.

– JCTEA STD-007-1.0, BS digital compliant Digital Cable Television Receiver.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 MPEG-2: Refers to ISO/IEC 13818 (All parts). Systems coding is defined in ITU-T H.222.0 | ISO/IEC 13818-1. Video coding is defined in ITU-T H.262 | ISO/IEC 13818-2. Audio coding is defined in ISO/IEC 13818-3 and in ISO/IEC 13818-7.

3.2 network: A collection of MPEG-2 transport stream multiplexes transmitted on a single delivery system, e.g., all digital channels on a specific cable system.

3.3 original_network_id: A label identifying the network_id of the originating delivery system.

3.4 programme: A concatenation of one or more events under the control of a broadcaster, e.g., news show, entertainment show.

3.5 physical interface: The interface on a physical layer equipment for transmission.

3.6 reserved_for_future_use: The term "reserved_for_future_use", when used in the clause defining the coded bitstream, indicates that the value may be used in the future defined extensions. All "reserved_for_future_use" bits shall be set to "1".

3.7 set-top box: A hardware box that contains digital signal demodulator, de-multiplexer, MPEG-2 decoder, other functionalities and interfaces related to digital signal reception and presentation of the distributed programme at the subscriber's site.

3.8 transport stream (TS): A TS is a data structure defined in ITU-T H.222.0 | ISO/IEC 13818-1.

3.9 transport_stream_id (TS_id): A unique identifier of a TS within an original network.

4 Abbreviations

This Recommendation uses the following abbreviations:

bslbf	bit string, left bit first
CRC	Cyclic Redundancy Check
rpchof	remainder polynomial coefficients, highest order first
TS	Transport Stream
TSMF	Transport Streams Multiplexing Frame
uimsbf	unsigned integer, most significant bit first

5 Multiple-TS transmission system

The proposed framing structure for a multiple-TS transmission system meets the following requirements:

a) Multiple MPEG-2 transport streams should be transmitted over a digital carrier in compliance with existing cable TV systems.

b) All packets of all MPEG-2 transport streams should be transmitted without any packet loss.

c) All transport streams received are in compliance with the specification of MPEG-2 systems.

d) The system should make effective use of cable TV channel capacity.

e) Delay time resulting from optional use of signal processing should not affect digital broadcasting services.

f) The added cost of introduction of the optional facilities in a cable TV headend and the receiver should be low.

g) The system should support interoperability with conventional single transport stream transmission systems for cable distribution.

5.1 Framing structure for multiple-TS transmission

The multiple-TS transmission system uses the frame structure shown in Table 1 to multiplex MPEG-2 transport streams (TSs). The frame is called the transport streams multiplexing frame (TSMF). The TS packets shall be assigned to slots in the TSMF. A slot is constituted from 188 bytes of the same size as a TS packet, and the TSMF consists of N slots. The TSMF has a TSMF_header in the first slot. In the TSMF_header, information about multiplexing and de-multiplexing is contained. By outputting this frame repeatedly, multiple TSs are transmitted.

Table 1/J.183 – TSMF structure

Syntax	No. of bytes	Description
TSMF () {		
TSMF_header()	188	
for (i = 1; i < N; i++){		
TS_packet[i]	188	
}		
}		

5.2 Physical interface and channel coding of the multiple-TS transmission system

Except for the framing block, channel coding is identical to that of the single-TS transmission system (Figure 1) because the multiplexed signal by using the TSMF is a stream of TS packets. The technology and standards specified for the physical interface of a single-TS transmission system, for example, ITU-T J.83, can be applied.

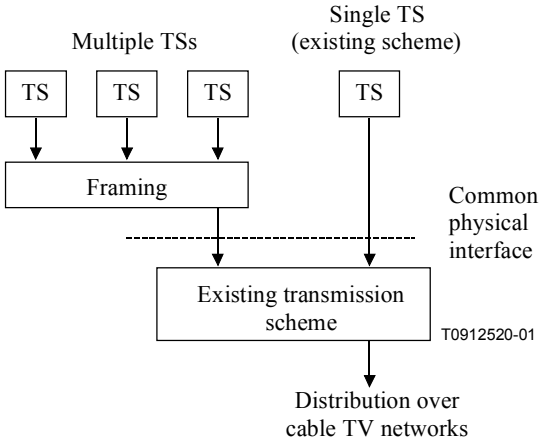

Figure 1/J.183 – System configuration for single TS and multiple TSs transmission

5.3 TSMF header structure

The TSMF_header should be comprised of 188-byte data. The first byte of 0x47 is for packet synchronization purpose, followed by 187 bytes of the following information:

– frame synchronization;

– MPEG-2 TS identification for each slot; and

– others (e.g. version number, flag bit for emergency alert broadcasting).

Each of the MPEG-2 TSs, multiplexed in the TSMF, is uniquely distinguished by the TS identification (TS_id) and original network identification (original_network_id). Instead of directly using the corresponding information between a slot number and TS_id/original_network_id, the relative TS number (relative_TS_number) is employed. The TS_id/original_network_id of a TS, which a TS_packet in a slot belongs to, is resolved in two stages: the first is translation of slot number to relative_TS_number, and the next is translation of relative_TS_number to TS_id/original_network_id. This method reduces the number of bits for the TS identification in the TSMF_header. The content of the TSMF_header is specified in Table 2 and below:

Table 2/J.183 – TSMF_header

Syntax	No. of bits	Description
TSMF_header() {		
packet_header()	32	
TSMF_sync	16	bslbf
version_number	V	
slot_information()	S	
identifiers_information()	32 * M	M = 2^m – 1
control_information()	C	bslbf
relative_TS_information()	m * (N – 1)	
private_data	1424 – V – S – 32 * M – C – m * (N – 1)	
CRC	32	rpchof
}		

NOTE 1 – The semantic definition of the fields in the TSMF header is as follows:

TSMF_sync: This is a 16-bit field. Its value shall be determined by the system.

version_number: This V-bit field is the version number that indicates renewal of the area from the slot_information to the control_information in the TSMF_header. It shall be incremented by 1 when a change occurs. When it reaches maximum value, it wraps around to 0.

private_data: This is a field whose syntax and semantics shall be defined by the system.

CRC: CRC (cyclic redundancy check) is added to detect any errors. As defined in ITU-T H.222.0, the value of CRC has zero register output when 184 bytes of a TSMF_header, excluding the first 4 bytes, are input into the register of a decoder.

NOTE 2 – $V + S = 8 * I_1$, where V is the number of bits for version_number, S is the number of bits for slot_information, and I_1 is an integer.

NOTE 3 – $C = 8 * I_2$, where C is the number of bits for control_information, and I_2 is an integer.

NOTE 4 – N is the number of slots in the TSMF, or the total length of the frame.

NOTE 5 – M is the maximum number of transport streams multiplexed in the TSMF.

5.3.1 Packet_header

The first 4 bytes of the TSMF_ header have a structure similar to the MPEG-2 TS packet header, as shown in Table 3.

Table 3/J.183 – Packet_header

Syntax	No. of bits	Description
packet_header() {		
sync_byte	8	bslbf
'000'	3	bslbf
TSMF_header_PID	13	uimsbf
'0001'	4	bslbf
continuity_counter	4	uimsbf
}		

NOTE – The semantic definition of the fields in packet header is as follows:

sync_byte: This is a fixed 8-bit field whose value is '0100 0111' (0x47).

TSMF_header_PID: This is a 13-bit field whose value is set to a unique value other than the PIDs of TS packets. The TSMF_header can be identified from other TS packets, as the value of TSMF_header_PID is unique.

continuity_counter: The continuity_counter is a 4-bit field incrementing with each TSMF_header. When the value reaches '1111' (0x0f), it wraps around to 0.

5.3.2 TSMF_sync

The TSMF_sync is used for frame synchronization. Using the TSMF_sync and the TSMF_header_PID together, frame synchronization is ensured. The value shall be defined by the system.

5.3.3 Version_number

The version_number indicates renewal of the TSMF_header information. It shall be incremented each time the TSMF header is renewed. The receiver may decode the TSMF header information only when a change of information occurs. The use of version number and the area where information renewal is examined are optionally defined by the system.

5.3.4 Slot_information

The slot_information (see Table 4) shall include the TSMF_format, and the indicator of the availability of each relative_TS_number, and so on. The TSMF_format may indicate the maximum number of TSs transmitted simultaneously and the number of slots in the TSMF. Each of the availability_for_relative_TS_number shall be transmitted sequentially in order of the relative_TS_number from 1 to M.

Table 4/J.183 – Slot_information

Syntax	No. of bits	Description
slot_information() {		
TSMF_format	F	bslbf
for (i = 1; i <= M; i++) {		M = 2^m – 1
availability_for_relative_TS_number[i]	1	bslbf
}		
reserved_for_future_use	S-F-M	
}		

NOTE 1 – F is the number of bits of TSMF_format.

NOTE 2 – M is the maximum number of transport streams multiplexed in the TSMF.

NOTE 3 – S is the number of bits of slot_information.

NOTE 4 – Semantic definition of the fields in the slot information is as follows:

TSMF_format: This is a V-bit field which indicates N and M. The value of N and M should be the same as defined in Annex C/J.94.

availability_for_relative_TS_number[i]: This is a 1-bit field that represents availability of the TS labelled by relative_TS_number i.

5.3.5 Identifiers_information

Table 5 shows the algorithm relating relative_TS_number and TS_id/original_network_id. TS_id/original_network_id shall be composed of 32-bit numbers and shall be arranged in order of the relative_TS_number from 1 to M.

Table 5/J.183 – Identifiers_information

Syntax	No. of bits	Description
identifiers_information(){		
for (i = 1; i <= M; i++) {		M = 2^m – 1
TS_id[i]	16	uimsbf
original_network_id[i]	16	uimsbf
}		
}		

NOTE 1 – The maximum number of TSs transmitted simultaneously, M, shall be indicated by the 'TSMF_format' as shown in Table 4.

NOTE 2 – The semantic definition of the fields in the identifiers information is as follows:

TS_id[i]: This is a 16-bit field that represents TS_id of the TS labelled as relative_TS_number i.

original_network_id[i]: This is a 16-bit field that represents original_network_id of the TS labelled as relative_TS_number i.

5.3.6 Control information

The control information may be used to control set-top boxes, e.g. a flag for emergency alert broadcasting. The encoding format shall be defined by the system. The number of bits for the control information, "C", is defined in Table 2.

5.3.7 Relative TS number information

The relative_TS_number for each TS_packet shall be transmitted sequentially in order of slot from 1 to (N – 1) as shown in Table 6. The number of slots in TSMF, N, shall be defined by the system.

Table 6/J.183 – Relative TS_number_information

Syntax	No. of bits	Description

relative_TS_information(){
for (i = 1; i < N; i++) {
relative_TS_number[i]
}
}
	m	uimsbf

NOTE 1 – M is 2^ m – 1.

NOTE 2 – Semantic definition of the fields in the relative TS number information is as follows:

relative_TS_number[i]: This is an m-bit field that represents the relative_TS_number of the i-th TS_packet.

APPENDIX I

Table I.1 shows parameters for the TSMF employed with the physical layer interface specified in Annex C/J.83.

Table I.1/J.183 – System parameters

Parameter	Notation	Value	Remarks
The number of slots in the TSMF, or the total length of the frame	N	53	including TSMF_header
The maximum number of transport streams multiplexed in the TSMF	M	15	
TSMF_sync			reserved 3 bits 0x1a86 13 bits
version_number			3 bits (V = 3)
slot_information			21 bits (S = 21)
TSMF_type			slot_allocation_type 1 bit frame_type[a] 4 bits (F = 5)
control_information			receive_status 2 * M = 30 bits emergency_indicator 1 bit
private_data			85 bytes

[a] The "frame_type" in the TSMF_type should be included in the cable delivery system descriptor of network information table (NIT) for the reception. The set-top box could identify whether each channel on cable network is with the TSMF or not. The values of N and M are identical to the definition in Annex C/J.94.

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Geneva, 2001