

## RECOMMENDATION ITU-R BT.1126\*

**Data transmission protocols and transmission control scheme  
for data broadcasting systems using a data channel  
in satellite television broadcasting**

(1994)

The ITU Radiocommunication Assembly,

*considering*

- a) that a common transmission protocol should be applied to the data channel of both the digital sub-carrier NTSC system (recommended in Recommendation ITU-R BO.650) and the MUSE system (recommended in Recommendation ITU-R BO.786);
- b) that various data broadcasting services, such as broadcasting facsimile, telesoftware, digital coded still picture, telemusic etc., are available;
- c) that multimedia services combined with the above services are also available;
- d) that flexibility for the various applications is required;
- e) that expandability is required to expand the several services that appropriate the new technology and the needs of service broadcasters and users;
- f) that various services can be transmitted efficiently through a data channel with a limited transmission capacity;
- g) that a flexible conditional access system is desirable to realize several billing systems and several security levels;
- h) that the desired packets are separated from all the packets of the services broadcast by the several service broadcasters through the data channel with various formats;
- j) that undesired packets must not operate the receiver;
- k) that the quality of the data is secured when the received TV picture quality is poor;
- l) that it is desirable that a technical standard be described in accordance with Recommendation ITU-R BT.807 to facilitate interoperability;
- m) that it is desirable that protocols of layers 1 to 4, which include data transmitting functions, are common in the data broadcasting services to encourage the development of compatible reception circuits; it is desirable that the protocol of layer 5, which includes data handling functions, is common to implement multimedia services and to realize a simple data access method; it is desirable that protocols of layer 6 and layer 7 can be optimized in each service,

*recommends*

**1** that the data broadcasting system using the data channel of the digital sub-carrier NTSC system and the MUSE system as described in Recommendations ITU-R BO.650 and ITU-R BO.786 respectively, should use the data transmission protocols shown in Annex 1, the transmission control scheme shown in Annex 2, and the conditional access system shown in Annex 3.

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\* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in 2002 in accordance with Resolution ITU-R 44.

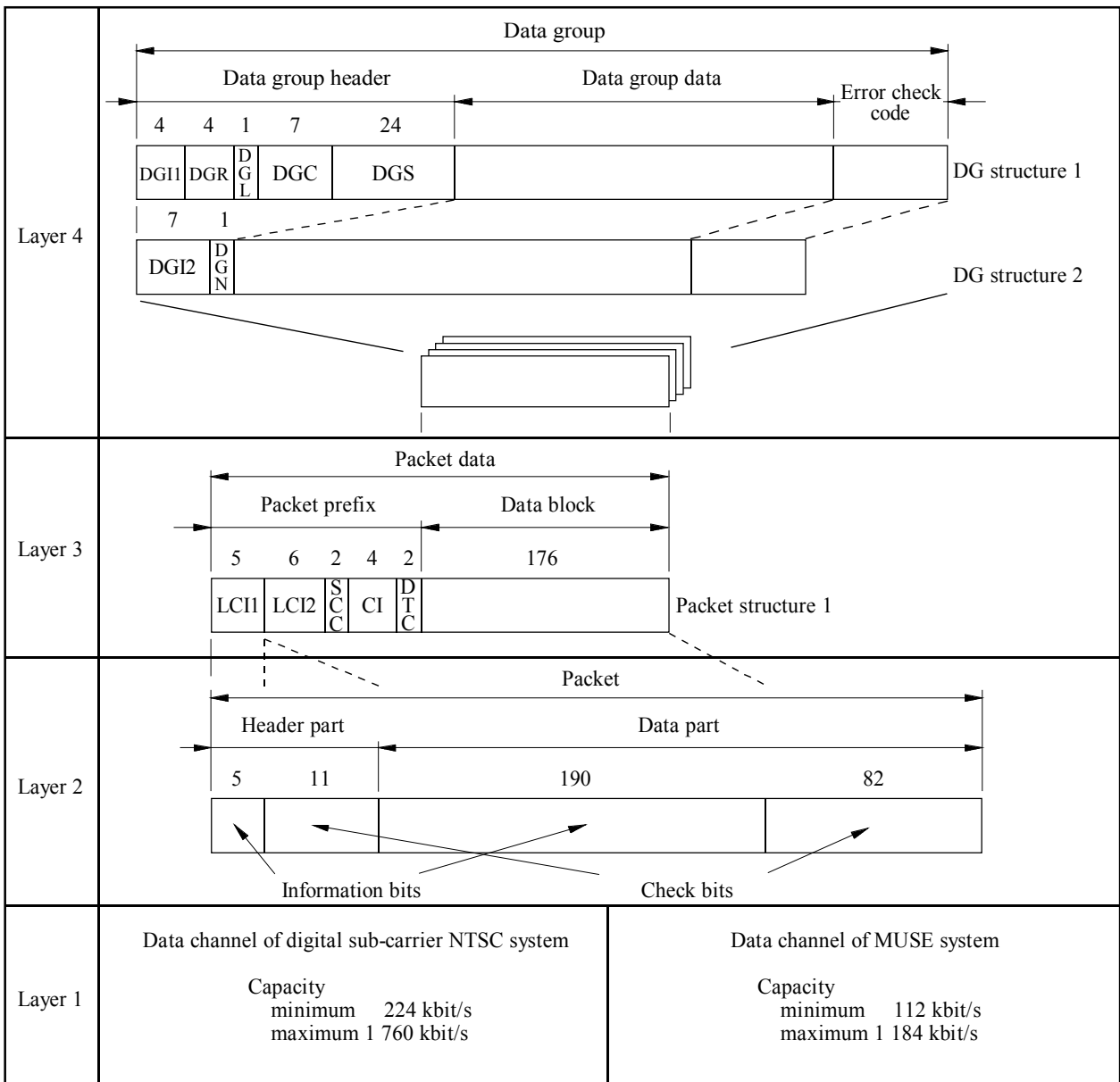
ANNEX 1

**Data transmission protocols of layers 1 to 4 of the data channel**

**1 Introduction**

The data transmission protocols of layers 1 to 4 are shown in Fig. 1 according to Recommendation ITU-R BT.807. Protocols of the upper layers (layers 5 to 7) are determined for each service.

FIGURE 1  
Data transmission protocols of layers 1 to 4



CI: continuity index  
 DG: data group  
 DGC: data group continuity  
 DGI: data group identifier  
 DGL: data group link  
 DGN: data group renewal

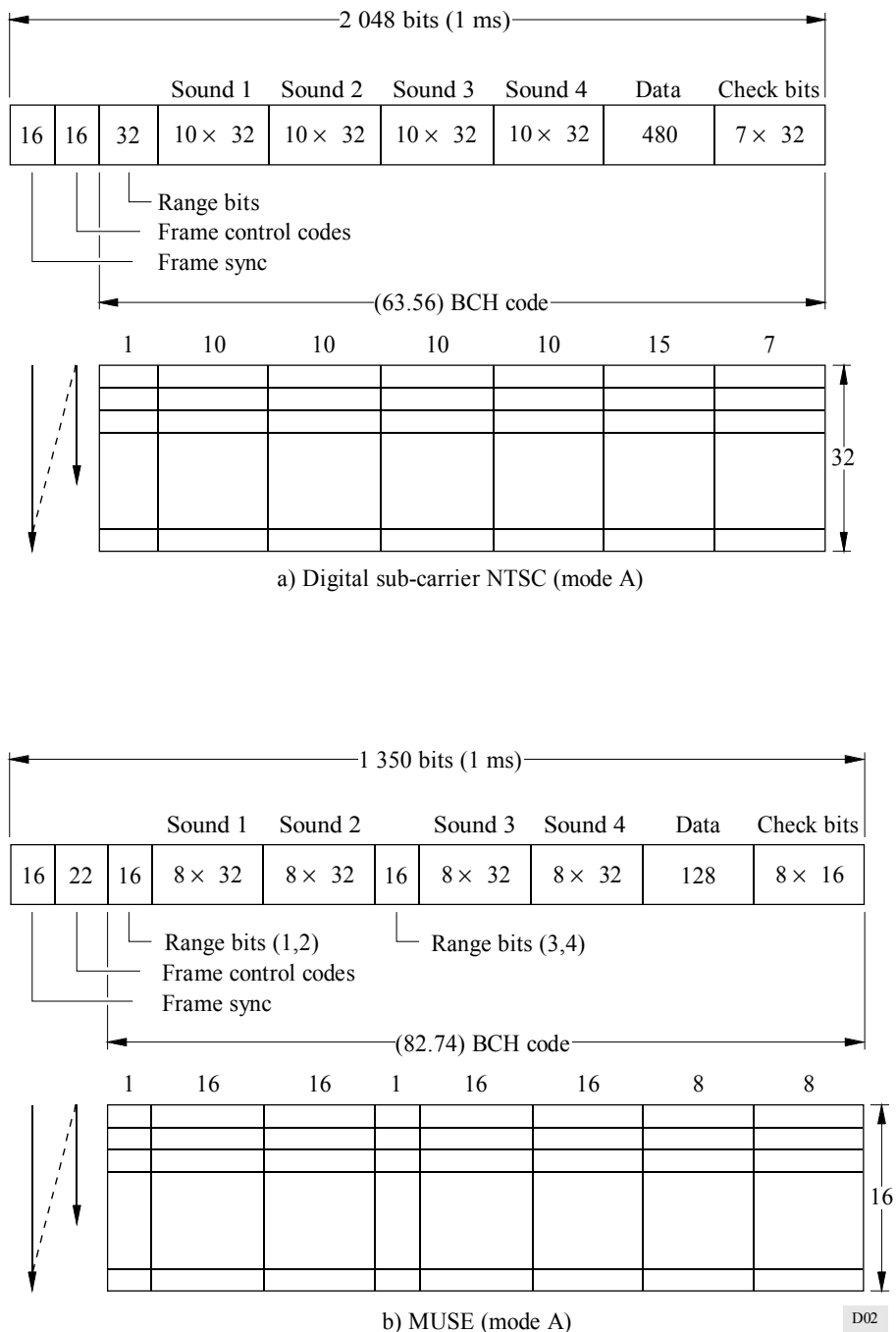
DGR: data group repetition  
 DGS: data group size  
 DTC: data transmission control  
 LCI: logical channel identification  
 SCC: scramble control

## 2 Layer 1 (physical)

The digital sub-carrier NTSC system is recommended in Recommendation ITU-R BO.650 and the MUSE system is recommended in Recommendation ITU-R BO.786.

Frame formats for the digital sound/data signal in the digital sub-carrier NTSC system and the MUSE system are shown in Fig. 2. Each bit in the frame is transmitted in an interleave process. The bit stream of the digital sub-carrier NTSC system is 4-phase DPSK modulated by a 5.73 MHz sub-carrier, and the modulated signals are multiplexed in the upper frequency band of the baseband signal. On the other hand, the bit stream of the MUSE system is frame-interleaved after the bit-interleave process, time-compressed, transformed into a ternary code and inserted in the vertical blanking period.

FIGURE 2  
Frame formats for the digital sound/data signal



There are areas in the frame format of both systems exclusively dedicated to data transmission. The data channel areas are defined as the remaining areas in the frame not used for transmitting sound. They are defined by 5 bits of the frame control codes in the digital sub-carrier NTSC system and by 6 bits in the MUSE system. Consequently, the actual data rate depends on the use of sound areas in the digital channel. As shown in Table 1, it varies between 224 and 1 760 kbit/s in the digital sub-carrier NTSC system and 112 and 1 184 kbit/s in the MUSE system.

TABLE 1  
Capacity of data channel

Sound mode	Number of sound channels	Capacity of data channel (kbit/s)	
		Digital sub-carrier NTSC	MUSE
A/B	0	1 760	1 184
A	1	1 440	912
	2	1 120	656 or 640
	3	800	384
	4	480	128
B	1	224	640
	2	224	112

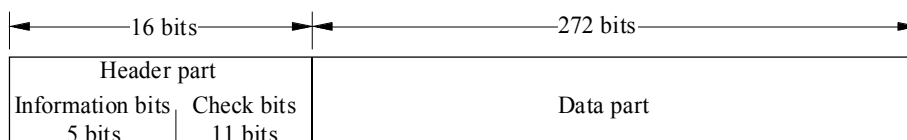
The majority decision logic of the frame control codes lasts for 36 ms and this period is called the “master frame”. The data channel mode of the next period of the master frame is decided in this period. A bit for identifying the master frame is assigned to the frame control codes. The start frame for packet multiplexing can be identified by this bit. The number of packets multiplexed during a master frame is an integer.

### 3 Link (layer 2)

#### 3.1 Packet structure

Figure 3 shows the packet structure. It is composed of a header and a data part. The length of a packet is fixed at 288 bits.

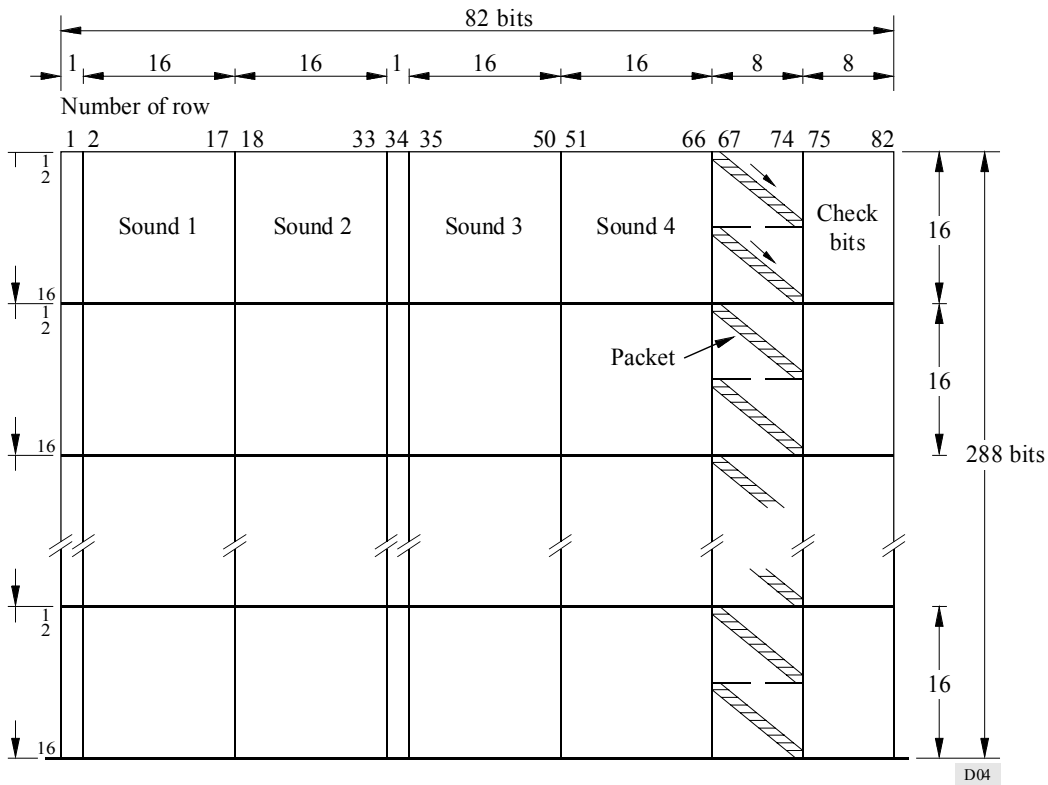
FIGURE 3  
Packet structure



### 3.2 Bit assignment of packet in the data channel

Diagonal multiplexing is used for the bit assignment of packets in the data channel area. Figure 4 shows an example.

FIGURE 4  
 Super-frame structure of the sound/data multiplex and bit assignment of packets in the data channel area (showing the case when four sound channels are used in mode A of the MUSE system)



### 3.3 Error correction code for data block

The (16,5) BCH code is applied to the header part. This code can correct all errors up to three bits and detect errors up to four bits.

The (272,190) code can be used to correct bit errors in the data part. However, other error correction codes and methods without correction code can also be used in the data part.

## 4 Network (layer 3)

### 4.1 Structure of packet data

The packet data are composed of the five information bits in the header part and the information bits in the data part. Two types of packet data structure are designed for the error correction codes: “packet structure 1” for the (272,190) code and “packet structure 2” for other error correction codes or for data without error correction code. At present, only packet structure 1 can be used.

## 4.2 Packet structure 1

The packet data are composed of five information bits in the header part and 190 bits in the data part. The five information bits are named logical channel identification 1 (LCI1). LCI1 and the first 14 bits of the information bits are named the packet prefix. The remaining 176 bits in the information bits are named data block. Figure 5 shows the packet data structure of the packet structure 1.

FIGURE 5

**Packet data structure of packet structure 1**

Packet prefix		Data block
5 bits	14 bits	176 bits

## 4.3 Packet prefix (PF)

PF is composed of the logical channel identification 1, logical channel identification 2, scramble control, continuity index, and data transmission control flag. Figure 6 shows the structure of the packet prefix. The functions are as follows:

FIGURE 6

**Structure of packet prefix**

Logical channel identification 1	Logical channel identification 2	Scramble control	Continuity index	Data transmission control flag
LCI1 5 bits	LCI2 6 bits	SCC 2 bits	CI 4 bits	DTC 2 bits

### 4.3.1 Logical channel identification 1 (LCI1) and logical channel identification 2 (LCI2)

The combination of LCI1 and LCI2 is used to identify the logical channel.

### 4.3.2 Scramble control (SCC)

Data packets are scrambled so that a common scrambling method can be used in different services of the data channel. For this purpose, a scramble identification flag bit and a load timing flag bit for a new scramble key are used.

### 4.3.3 Continuity index (CI)

CI is an index for packet transmission continuity and is used for detecting packet-losses during transmission.

### 4.3.4 Data transmission control flag (DTC)

For data transmission control, a flag bit indicating the initial packet of a data group and a flag bit indicating the termination packet of a data group are used.

## 5 Transport (layer 4)

The data group is a group of data organized into a transportable logical unit. A data group is carried by one or many continuous data blocks transmitted in sequence in the same logical channel with the given LCI1 and LCI2.

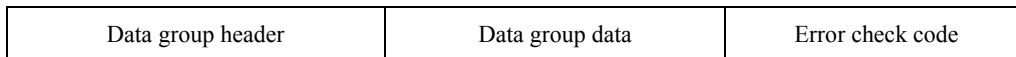
Four transmission methods have been designed; that is, three types of data group structure and one method that does not use any kind of data group structure. The three data groups are “DG structure 1”, “DG structure 2”, and “DG structure 3”. DG structure 1 and DG structure 2 are defined below. DG structure 3 is to be defined for extension in the future.

### 5.1 DG structure 1

The data group of DG structure 1 is composed of a data group header, data group data, and an error check code for the data group. The data group header is located in the heading of the data group. The error check code is located at the end of the data group. Figure 7 shows the structure of the data group of DG structure 1.

FIGURE 7

Structure of data group of DG structure 1

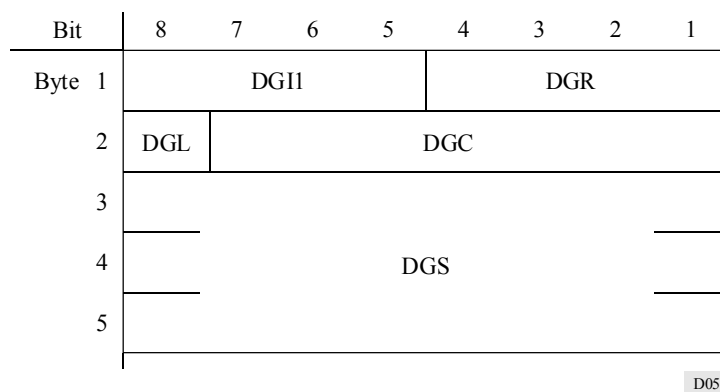


#### 5.1.1 Data group header

Figure 8 shows the structure of the data group header of DG structure 1.

FIGURE 8

Structure of the data group header of DG structure 1



### 5.1.1.1 Data group identifier 1 (DGI1)

DGI1 identifies the class of data structures in the data group data. Assignment of DGI1 can differ in each service.

### 5.1.1.2 Data group repetition (DGR)

To secure more reliability, a data group is transmitted repeatedly. DGR indicates the number of repetitions. The number of the DGR is incremented each time the same data group is sent. The value zero indicates that the data group will not be repeated.

### 5.1.1.3 Data group link (DGL)

DGL set to 1 indicates that there is a linked new data group that will be transported after the current data group. Data group linkage may be carried out between data groups with the same data group identifier transmitted in sequence in the same logical channel.

### 5.1.1.4 Data group continuity (DGC)

DGC is the serial number of data groups, which is increased by one each time a linked new data group is transmitted.

### 5.1.1.5 Data group size (DGS)

DGS indicates the size of the data group data in the data group by byte length.

## 5.1.2 Error check for the data group

The data group is protected by a cyclic redundancy check (CRC) code. The CRC is a check code of 16 bits generated by the generator polynomial  $G(x)$ :  $G(x) = x^{16} + x^{12} + x^5 + 1$ .

$G(x)$  is adopted in the ITU-T Recommendation and is generally used. With this code, fewer than 16 bits of burst error, fewer than 3 bits of random error, and odd bit errors can be detected. The check code is the remainder obtained by dividing a data bit polynomial by  $G(x)$ .

## 5.2 Data group of DG structure 2

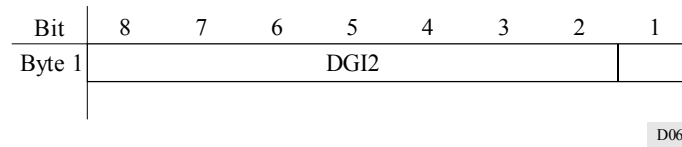
The data group of DG structure 2 is composed of a data group header, data group data, and an error check code. The structure of the data group of DG structure 2 is same as DG structure 1.



### 5.2.1 Data group header

Figure 9 shows the structure of the data group header of DG structure 2.

FIGURE 9  
Structure of the data group header of DG structure 2



#### 5.2.1.1 Data group identifier 2 (DGI2)

DGI2 identifies the class of data structures in the data group data. Assignment of DGI2 may differ in each service.

#### 5.2.1.2 Data group renewal (DGN)

DGN identifies renewal of the data group transmitted in the same DGI2.

### 5.2.2 Error check for the data group

The data group is protected by the CRC code described in § 5.1.2.

## ANNEX 2

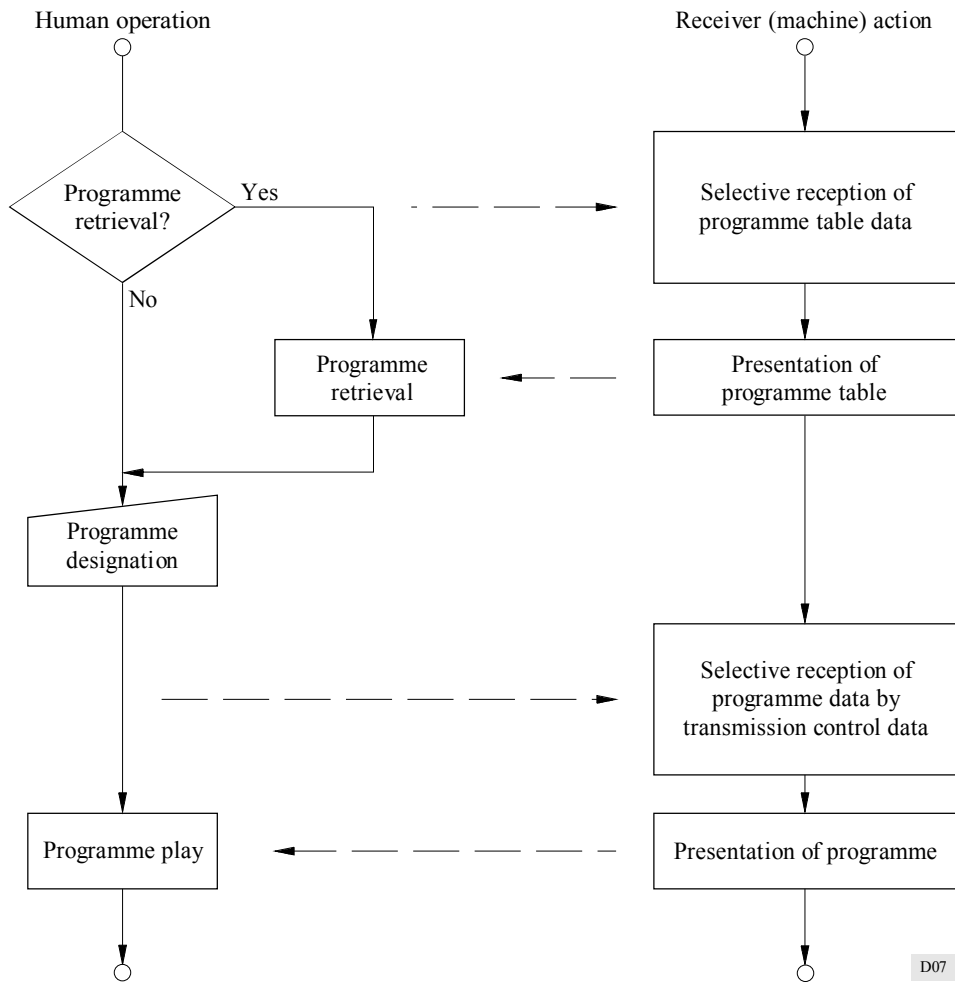
### Transmission control scheme with transmission control data

#### 1 Introduction

Common operation of data receivers selecting services and programmes is desirable. Figure 10 is a general flowchart of programme selection. There are two stages in programme selection: the desired programmes are designated at the first stage and the desired packets of the designated programme are selected in the receiver at the second stage. Programme table data on various data services should be transmitted together with other services for easy programme selection at the first stage. The relationship between the programme identifiers and the packet identifiers should also be transmitted. The data that express this relationship are called transmission control data. The packets required are easily selected by the receiver using the transmission control data at the second stage. According to this transmission control scheme with the transmission control data, multimedia services can be implemented easily. Furthermore, improvement of presentation coding and upgrading can be handled and implemented easily in the future.

Transmission control data are transmitted according to the transmission protocol shown in Annex 1. Layer 5 of the transmission control data is described below.

FIGURE 10  
General flowchart of programme selection

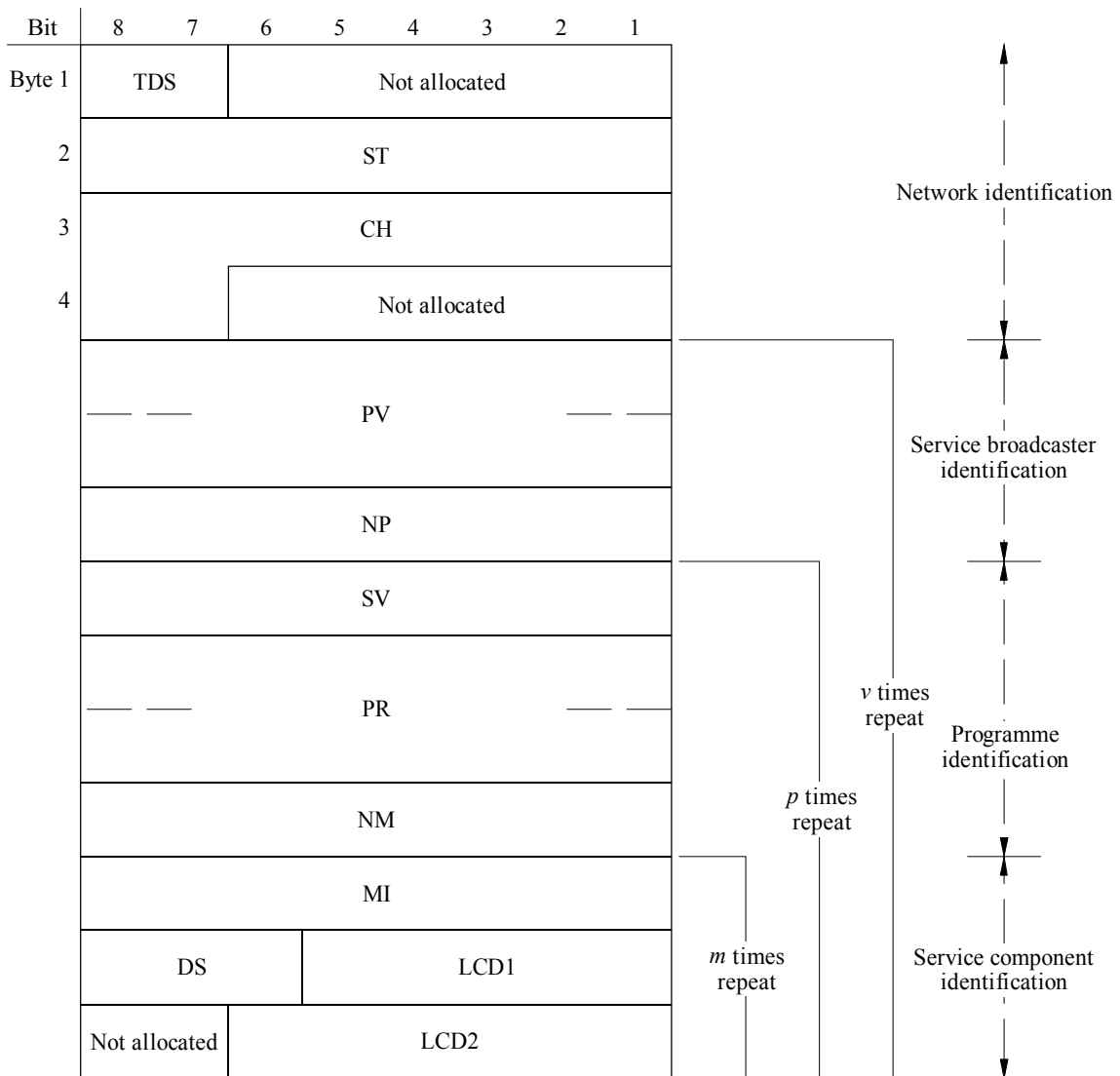


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## 2 Transmission control data (TCD)

TCD are composed of the network identification, the service broadcaster identification, the programme identification, and the service components identifications (the presentation coding method and the logical channel). Figure 11 shows the structure of the TCD.

FIGURE 11  
Structure of transmission control data



*v*: number of service broadcaster  
*p*: value of NP  
*m*: value of NM

### **3 Network identification**

#### **3.1 Data structure of transmission control data TDS**

TDS identifies the data structure of the transmission control data.

#### **3.2 Station identification (ST)**

ST identifies the broadcasting station that transmits data multiplexed in the television.

#### **3.3 Transmission channel (CH)**

CH identifies the transmission channel of the ST.

### **4 Service broadcaster identification**

#### **4.1 Service broadcaster (PV)**

PV identifies the service broadcaster.

#### **4.2 Number of programme (NP)**

NP indicates the number of the programme provided by the service broadcaster of PV.

### **5 Programme identification**

#### **5.1 Service number (SV)**

SV identifies the kind of service.

#### **5.2 Programme number (PR)**

PR identifies the programme in combination with SV.

#### **5.3 Number of service components (NM)**

NM indicates the number of service components of the programme designated with the SV and PR codes.

### **6 Service component identification**

#### **6.1 Media identification (MI)**

MI indicates the presentation coding method of the service component with which picture, sound, text and facsimile are coded.

## **6.2 Logical channel identification 1 (LCD1) and logical channel identification 2 (LCD2)**

LCD1 and LCD2 identify the logical channel with which the service component is transmitted.

## **6.3 Data structure (DS)**

DS identifies the packet structure and the data group structure used by the service component identified with MI.

## **7 Transmission protocol of the TCD**

TCD uses the packet structure 1 and the DG structure 1.

### **7.1 Logical channel for TCD**

The logical channel for transmitting TCD is fixed.

## **ANNEX 3**

### **Conditional access system of data channel**

#### **1 Introduction**

The following are specified for the flexible and independent implementation of a conditional access system. Under these constraints, any conditional access system is operable at the service provider's choice. However, for maximum commonality, a general-purpose scramble sub-system is specified to be the standard recommended system. An outline of the recommended scramble system is shown in Table 2, and this system is based on Recommendation ITU-R BT.810.

#### **2 Scrambling**

##### **2.1 Scope of scrambling**

The first 17 bits of the packet prefix should be transmitted as clear bits. Scrambling must be processed before the parity bits of the packet are generated and added.

##### **2.2 Control of scrambling**

###### **2.2.1 Scrambling identification flag**

A scrambling identification flag is transmitted at the 12th bit of the packet prefix. The scrambling identification flag indicates whether the packet is scrambled or not. If the flag is set to 1, the packet data are not available without de-scrambling.

TABLE 2

## Outline of conditional access system

Implementation	Data channel of digital sub-carrier NTSC system and MUSE system
Scrambling process	<p>Exclusive-OR combination or block encryption of the packet data bits (except the 1st to 17th bits of the packet prefix), before generating parity bits of the packet. The scrambling identification flag in the packet prefix indicates whether the packet is scrambled or not.</p> <p>Details may be specified by the service provider but the recommended scrambling system is specified.</p> <p>Recommended system: exclusive-OR combination bit-by-bit of the packet data bits except packet prefix bits) with the bits of a pseudo-random generator</p>
Pseudo-random generator	Recommended system: non-linear combination of the output of three multi-stage linear feedback shift registers (13, 11, 8 stages each)
Pseudo-random generator synchronization	Recommended system: first scrambling bit of each packet
Initialization word	Recommended system: 32 bits
Control word	Recommended system: 36 bits (32 random bits and 4 modification control flags)
Initialization modifier	<p>Recommended system: 15 bits of the packet prefix (11 bits of logical channel identifier and 4 bits of continuity index), and carry information of the continuity index.</p> <p>Modification control flags in the control word indicate whether the modifiers are activated or not</p>
Effect control	Not applicable
Entitlement checking messages (ECM)	Packets designated in the transmission control data. Details may be specified by the service provider
Control word index	Not applicable
Change of control word and flag	Scrambling timing flag in the packet prefix
Entitlement management messages (EMM)	<p>Packets designated in the transmission control data. Details may be specified by the service provider.</p> <p>Also the telecommunication network or a physical carrier may be available</p>
Access control equipment	Built into the receiver or functionally separate
Security module	Provide for detachable module with interface to be standardized

### 2.2.2 Scramble timing flag

A scramble timing flag is transmitted at the 13th bit of the packet prefix. The scramble timing flag indicates the renewal timing of the scrambling key. If the flag is set to 1, the de-scrambling process must use the latest scrambling key transmitted.

### **3 Access control messages (ACM)**

#### **3.1 Transmission of ACM**

In the case of transmitting ACM within the satellite television broadcasting channel (the digital sub-carrier NTSC or the MUSE channel), they should be transmitted by a packet of the data channel specified in Annex 1.

#### **3.2 Logical channel for ACM**

ACM should be transmitted within the following logical channel designated in the transmission control data specified in Annex 2.

- Logical channel designated as MI = 1 of each programme.
- Logical channel designated as SV = 1, PR = 65280 and MI = 1 of each service provider.

The former logical channel is prepared for transmitting entitlement checking messages (ECM), and the latter for entitlement management messages (EMM).

#### **3.3 Configuration of ACM**

Any configuration, contents or encryption system of ACM is operable at the service provider's choice, provided that the ACM are packeted into packet data blocks.

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