

RECOMMENDATION ITU-R BO.1408-1

**Transmission system for advanced multimedia services provided
by integrated services digital broadcasting in
a broadcasting-satellite channel**

(Question ITU-R 3/6)

(1999-2002)

The ITU Radiocommunication Assembly,

considering

- a) that various kinds of information such as video, including high-definition television (HDTV) as well as limited-definition television (LDTV), audio, text, graphics, and data are provided to the public via the broadcasting channels;
- b) that information and services can be integrated efficiently and flexibly by using digital techniques;
- c) that integrated services digital broadcasting (ISDB) techniques can be used to implement services exploiting the full advantages of digital broadcasting;
- d) that the MPEG transport stream (MPEG-TS) is widely applied as a container of digitally coded information;
- e) that a great benefit is obtained if the integration of data/services can be achieved on a TS basis, which requires the transmission system to deal with multiple MPEG-TSs;
- f) that the recent progress in digital technology allows a highly bandwidth efficient modulation scheme such as 8-PSK in addition to the convolutionally-encoded QPSK and BPSK;
- g) that the required service quality and service availability differ according to applications;
- h) that rain attenuation, which differs by climatic zones, needs to be taken into account in satellite broadcasting systems;
- j) that a common ISDB transmission system that provides a high flexibility of use as well as high spectrum efficiency while covering all the requirements for application, quality and rain attenuation is desirable, rather than introducing multiple systems specifically developed for particular applications;
- k) that Recommendation ITU-R BO.1516 recommends common functional requirements for the integrated receiver-decoder (IRD) of digital multi-programme broadcasting by satellite,

noting

- a) that advanced multimedia systems for ISDB type services are characterised by highest flexibility with respect to:
 - handling several MPEG-TSs;
 - allowing time multiplex of appropriate modulation schemes suitable for applications of various transmission robustness, e.g. 8-PSK, QPSK and BPSK;
 - informing the demodulator about the transmission and multiplexing configuration by means of specially robust control signals;

- that the integrated circuits for satellite (ISDB-S) receivers could potentially be used for the system defined in Recommendation ITU-R BO.1516, because each of the components used in ISDB-S is also used in the systems defined in this Recommendation,

recommends

- 1 that the transmission system described in Annex 1 should be used for ISDB-S system applications.

ANNEX 1

General specifications for a generic satellite ISDB-S transmission system

Introduction

ISDB is a new type of broadcasting for multimedia services. It integrates, systematically, various kinds of digital content, each of which may include multi-programme video from LDTV to HDTV, multi-programme audio, graphics, texts, etc. Most digital content are nowadays encoded into the form of MPEG-TS and delivered worldwide. It is highly desired to integrate the digital content on an MPEG-TS basis.

Since the ISDB contains a variety of services, the system has to cover a wide range of requirements that may differ from one service to another. For example, a large transmission capacity is required for HDTV services, while a high service availability (or transmission reliability) is required for data services such as delivery of conditional access keys, downloading of software, etc. To integrate these signals of different service requirements, it is desired for the transmission systems to provide a series of modulation and/or error protection schemes which can be selected and combined flexibly in order to meet each requirement of the services integrated. This is especially true of the ISDB-S systems operating in the 11-12 GHz broadcasting-satellite service (BSS) band in countries that belong to the climate zones with high rain attenuation.

ISDB-S transmission systems are characterised by:

- MPEG interfacing: the input signals to the encoder and the output signals from the decoder conform to the MPEG-TS specifications;
- capability of signal integration on MPEG-TS basis: digital contents can be multiplexed without decoding/re-encoding of the input streams;
- flexible use of modulation schemes: digital content can be simultaneously transmitted with the appropriate modulation schemes for each integrated content in the ISDB stream;
- provision of a control signal that informs the receiver of the multiplexing and modulation configuration.

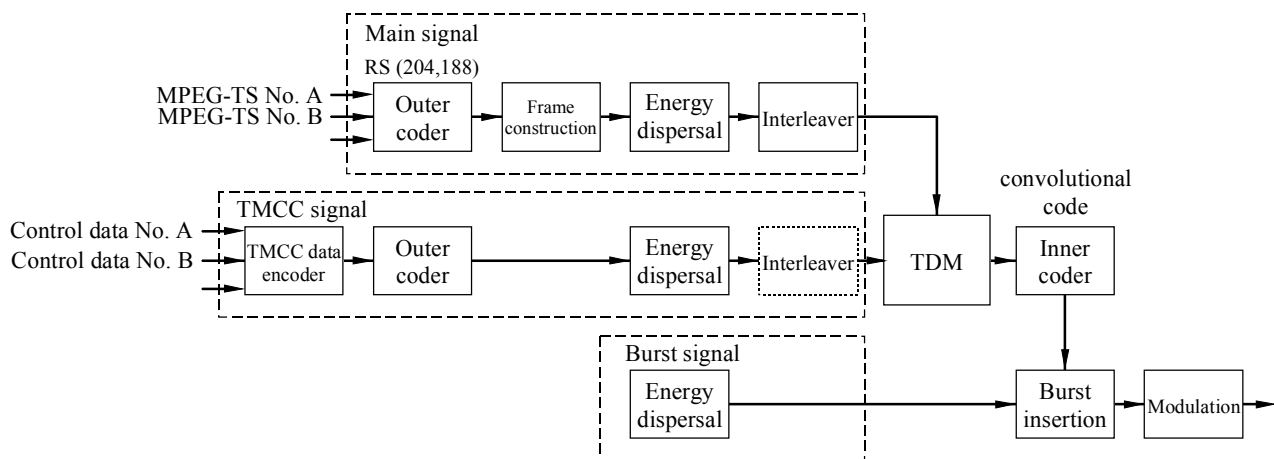
The generic system for ISDB-S is described below.

1 Block definition

A general configuration of the system is shown in Fig. 1. The system shall handle three kinds of signals in order to transmit multiple MPEG-TSs with various kinds of modulation schemes and in order to achieve stable and easy reception. The three signals shall be:

- main signal which consists of multiple MPEG-TSs and carries the programme content;
- transmission and multiplexing configuration control (TMCC) signal which informs the receiver of the modulation schemes applied, the identification of MPEG-TSs, etc.; and
- burst signal which ensures stable carrier recovery at the receiver under any reception condition (especially under low carrier-to-noise (C/N) ratio conditions).

FIGURE 1
General configuration of system



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To handle multiple MPEG-TSs and to allow several modulation schemes to be used simultaneously, a frame structure is introduced to the main signal. The input MPEG-TSs shall be combined into a single stream, to which ordinary signal processes for satellite systems are applied (i.e., energy dispersal, interleaving and inner coding). The control data which designates the modulation schemes, etc. for each TS packet shall be encoded into the TMCC signal, to which a series of channel coding is applied. In most cases, some parts of the channel coding can be shared with the main signal. The burst signal shall be energy-dispersed to avoid line spectra in the transmission signal. This is done by modulating the burst with a random sequence. Therefore, the burst signal can carry information by modulating it with information data instead of modulating it with a random sequence. In this case, an additional channel coding may be necessary. These three signals shall be time-division multiplexed (time division multiplex (TDM)) and modulated by the designated modulation schemes.

2 Outer code for main signal

Reed-Solomon (RS) (204,188) shortened code, from the original RS (255,239) code, shall be applied to each input MPEG-TS packet (188 bytes) to generate the error protected packet (204 bytes). The RS coding shall also be applied to the first byte of the packet (MPEG sync word).

- Code generator polynomial: $g(x) = (x + \lambda^0)(x + \lambda^1)(x + \lambda^2)(x + \lambda^{15})$,
where $\lambda = 02_h$
- Field generator polynomial: $p(x) = x^8 + x^4 + x^3 + x^2 + 1$.

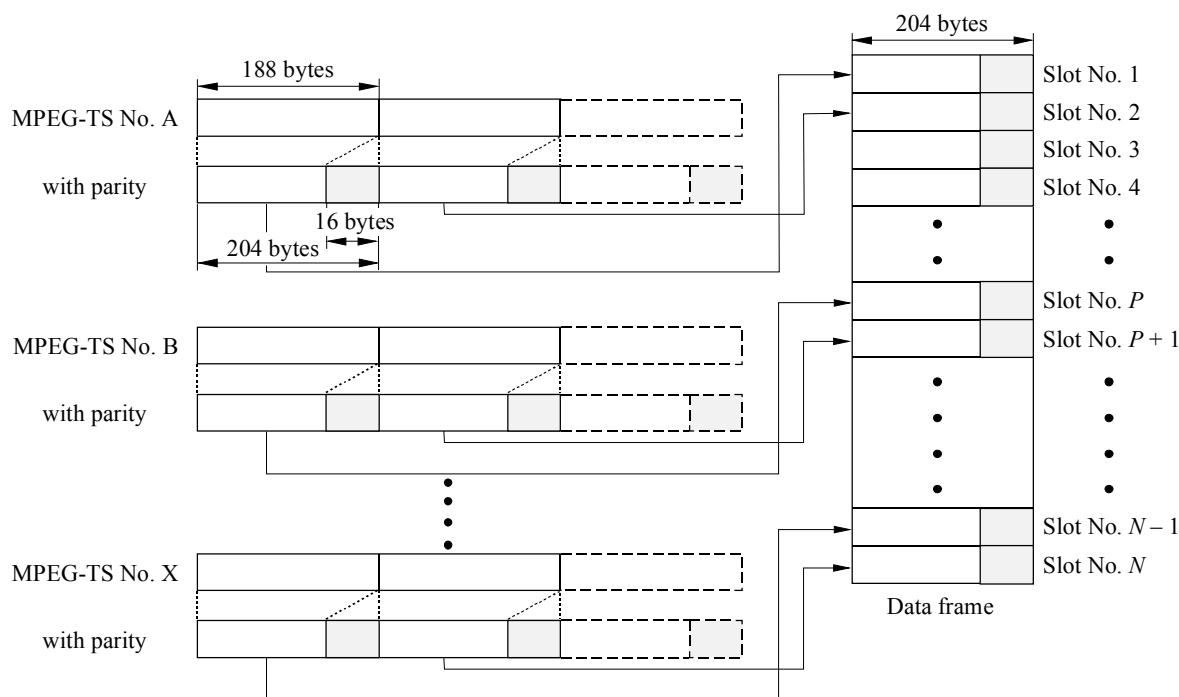
The shortened RS code may be implemented by adding 51 bytes, all set to zero, before the information bytes at the input of an RS (255,239) encoder. After the RS coding procedure, these null bytes shall be discarded.

3 Transport combiner

3.1 Framing structure

To combine the TSs, the error-protected 204-byte packets shall be assigned to the “slots” in a “data frame”, as shown in Fig. 2. The slot indicates the absolute position in the data frame and is used as the unit that designates the modulation scheme and MPEG-TS identification. The size of slot (the number of bytes in a slot) shall be 204 bytes to keep one-to-one correspondence between slots and error-protected packets. The data frame shall be composed of N slots.

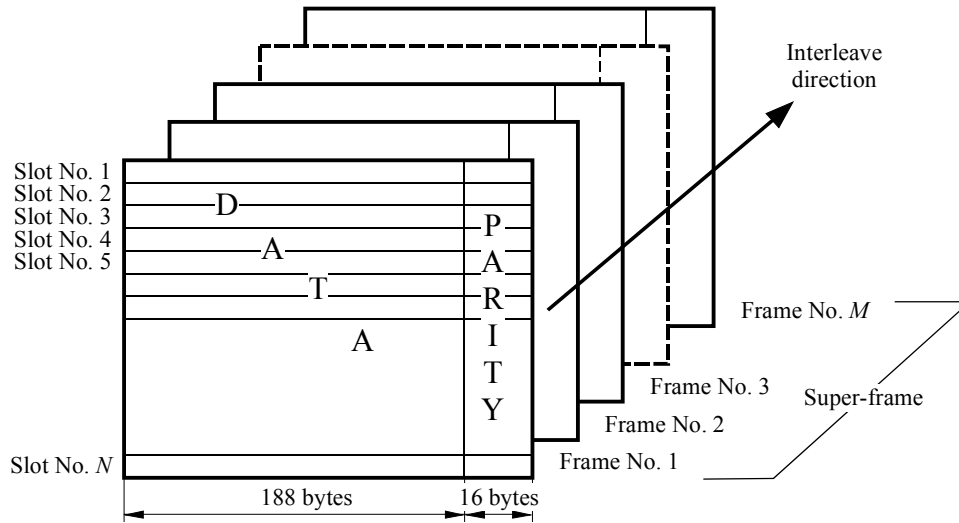
FIGURE 2
Frame structure



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A super-frame is introduced to perform interleaving easily. Figure 3 shows the super-frame structure. The super-frame shall be composed of M frames, where M corresponds to the depth of interleaving.

FIGURE 3
Super-frame structure



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3.2 Slot assignment

As the spectrum efficiency or the transmissible bits per symbol varies with the combination of modulation and inner code rate, the number of packets being transmitted depends on the combination. Since the number of symbols to be modulated by a particular modulation scheme must be an integer value, the relationship between the number of packets transmitted and the number of symbols for the modulation is given by equation (1).

$$I_k = \frac{8 B P_k}{E_k} \quad (1)$$

where:

I_k, P_k : integers

I_k : number of symbols transmitted with the k -th combination of the modulation scheme and inner code rate

P_k : number of packets transmitted with the k -th combination of the modulation scheme and inner code rate

E_k : spectrum efficiency of the k -th combination of the modulation scheme and inner code rate

B : number of bytes per packet (= 204).

The number of symbols per data frame, I_D , is expressed by equation (2).

$$I_D = \sum_k I_k \quad (2)$$

The number of packets transmitted during a frame duration becomes maximum when all the packets are modulated by the modulation-code combination having the highest spectrum efficiency among the possible combinations in the system. Therefore, the number of slots provided by the system is given by substituting the I_D and E_{max} for equation (1).

$$N = \frac{I_D E_{max}}{8 B} \quad (3)$$