



Recommendation ITU-R BO.1516-1
(01/2012)

**Digital multiprogramme television systems
for use by satellites operating in the
11/12 GHz frequency range**

BO Series
Satellite delivery



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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BO.1516-1

Digital multiprogramme television systems for use by satellites operating in the 11/12 GHz frequency range

(Question ITU-R 285/4)

(2001-2012)

Scope

This Recommendation proposes common functional requirements for four satellite digital multiprogramme reception systems for television, sound and data services. Annex 1 provides the common functional requirements for television transmissions through satellites operating in the 11/12 GHz frequency range.

The ITU Radiocommunication Assembly,

considering

- a) that digital multiprogramme systems have been designed for use by satellites in the 11/12 GHz frequency range;
- b) that these systems, being digital, provide significant advantages in service quality of video, sound and data, flexibility of use, spectrum efficiency and emission robustness;
- c) that these systems provide for a multiplicity of services such as TV programmes, multimedia elements, data services, audio channels and the like in a single multiplex;
- d) that these systems are either in widespread operational use or are planned to be in operational use in the near future;
- e) that significant advances have been made in digital multiprogramme system technology following the development of former Recommendation ITU-R BO.1294, and these advances are embodied in the system described in Recommendation ITU-R BO.1408;
- f) that integrated circuits compatible with some or all of the common elements of two or three of these systems have been designed, manufactured, and are in widespread use;
- g) that these systems have various distinguishing features that may make one or other of these systems more appropriate for the needs of an administration;
- h) that Resolution ITU-R 1 states that “When Recommendations provide information on various systems relating to one particular radio application, they should be based on criteria relevant to the application, and should include, where possible, an evaluation of the recommended systems, using those criteria”;

recommends

- 1 that administrations wishing to implement digital multiprogramme television services via satellite should refer to the characteristics described in Annex 1, § 4 as an aid in the selection of a specific system;
- 2 that one of the transmission systems described in Annex 1 should be selected when implementing digital multiprogramme television services via satellite;

3 that the common elements of the common functional requirements of a digital multiprogramme transmission system, as described in § 3 of Annex 1, should serve as a basis for implementation of the services in those areas where more than one system coexists or may coexist in the future.

Annex 1

Common functional requirements for the reception of digital multiprogramme television emissions by satellite operating in the 11/12 GHz frequency range

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1 Introduction

Since their introduction, satellite digital TV systems have continued to demonstrate their ability to efficiently use the satellite frequency spectrum and the ability to deliver high quality services to consumers. Four of these systems have been described in Recommendations ITU-R BO.1211, former ITU-R BO.1294 and ITU-R BO.1408.

With the aim to promote the convergence on a worldwide standard for satellite digital multiprogramme reception systems for television, sound and data services, the common functional requirements for the reception of digital multiprogramme television emissions by satellite were described in former Recommendation ITU-R BO.1294. In this Recommendation, common functional requirements and common elements were defined for a satellite integrated receiver-decoder (IRD) operating in the 11/12 GHz frequency range. Use in other frequency ranges was not and is not excluded. Former Recommendation ITU-R BO.1294 took into account the single system described in Recommendation ITU-R BO.1211.

The common elements of the satellite IRD as defined in former Recommendation ITU-R BO.1294 are capable of receiving emissions from three digital multiprogramme transmission systems. These systems were identified as Systems A, B and C. The common and unique elements of each of these systems were analysed, and it was concluded that practical implementation of the common elements of a satellite IRD was feasible. Since that time, the continued development of integrated circuits for use in these systems has clearly demonstrated this finding, with many integrated circuits now available that are compatible with the common elements of two or all three of these systems.

A fourth system has since been developed, and is described in Recommendation ITU-R BO.1408. It too shares the same common elements described in former Recommendation ITU-R BO.1294. It represents an advancement of the technology of these digital multiprogramme systems. It provides such added features as the ability to simultaneously support multiple modulation types, an hierarchical modulation scheme, and the ability to handle multiple Moving Picture Experts Group (MPEG) transport streams within a given carrier.

In the following sections of this Annex the common functional requirements and elements of these systems are briefly reviewed, and the functions of a generic digital multiprogramme transmission system are briefly described.

A summary and detailed system level characteristics of each of these four systems are also provided. These system level parameters are applicable to the implementation of either the transmission equipment or the integrated receiver decoder.

2 The generic reference model of digital multiprogramme transmission systems

2.1 Generic reference model

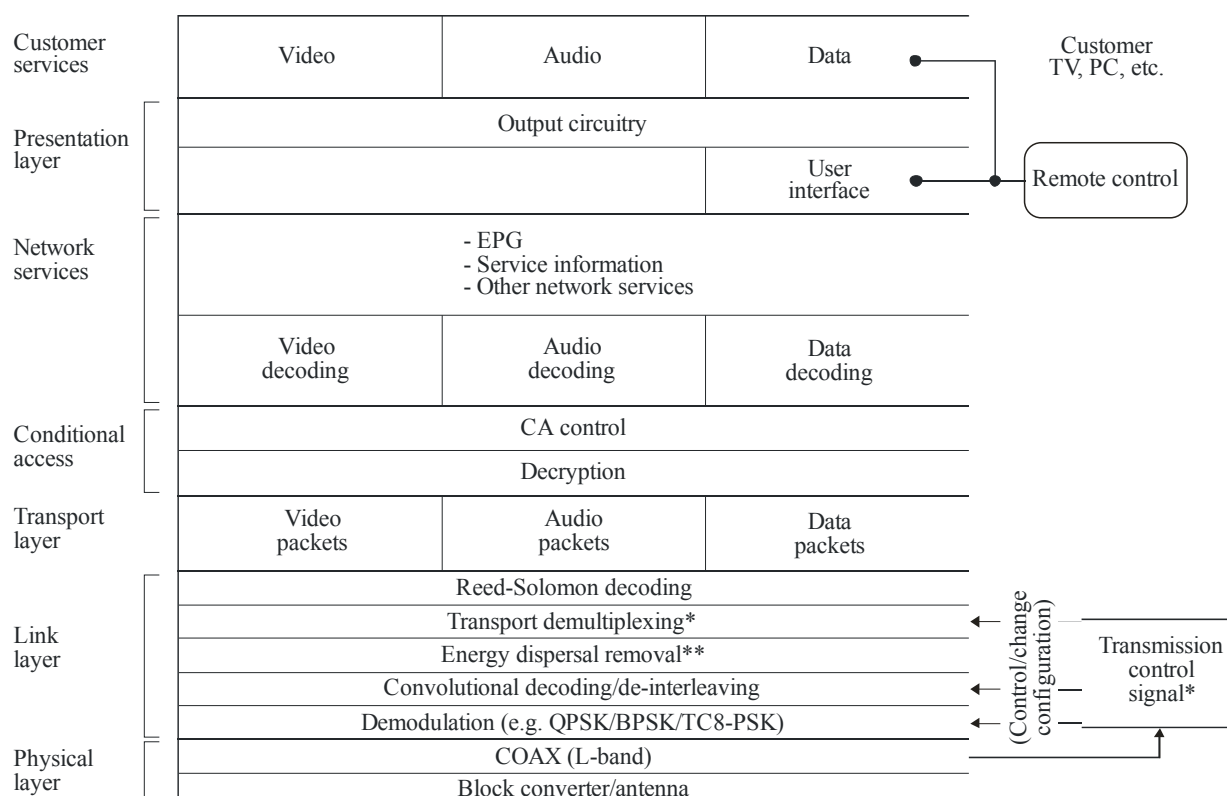
A generic reference model for the common functional requirements of a digital multiprogramme transmission system has been produced. This generic reference model has been shown to be applicable to all of the four systems described herein.

The generic reference model has been defined based on the common functions required over all layers of a digital multiprogramme transmission system protocol stack. It can be used to define the common functions required in an IRD for the reception of these transmissions.

For reference, Fig. 1 presents the typical IRD protocol stack which is based on the following layers:

- *Physical and link layers* covering the typical front-end functions: carrier generation and carrier reception (tuning), quadrature phase shift keying (QPSK) modulation and demodulation, convolutional encoding and decoding, interleaving and de-interleaving, Reed-Solomon encoding and decoding, and energy dispersal application and removal.
- *Transport layer* responsible for the multiplexing and demultiplexing of the different programs and components as well as the packetization and depacketization of the information (video, audio and data).
- *Conditional access* functions which control the operation of the external encryption and decryption functions and associated control functions (common interface for conditional access as an option).
- *Network services* performing video and audio coding and decoding as well as the management of electronic programme guide (EPG) functions and service information and, optionally, data decoding.
- *Presentation layer* responsible, among other things, for the user interface, operation of the remote control, etc.
- *Customer services* covering the different applications based on video, audio and data.

FIGURE 1
Typical IRD protocol stack



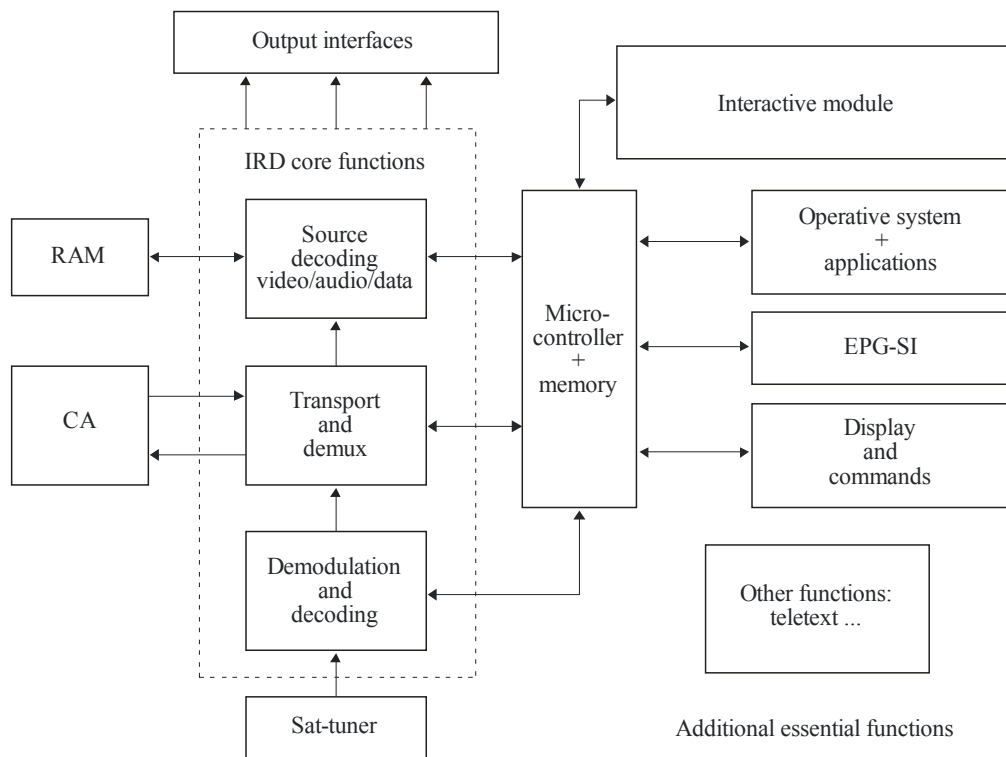
BPSK: binary PSK
 TC8-PSK: trellis-coded 8-PSK
 * Only present in System D.
 ** Not present in System B.

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2.2 Application to the satellite IRD

Based on the protocol stack, the generic block diagram for the satellite IRD (Fig. 2) can be derived. This is useful in demonstrating how the common elements are organized within the IRD.

FIGURE 2

Generic reference model for a satellite IRD

BO.1516-02

Two types of functions are identified in the generic reference model: IRD core functions and other additional essential functions:

- *The IRD core functions* cover the key IRD functions which define the digital TV system. IRD core functions include:
 - demodulation and decoding,
 - transport and demultiplexing,
 - source decoding video, audio and data.
- *The additional essential functions* are required to perform the operation of the system and upgrade it with additional and/or complementary features. These functions are closely related to the service provision. The following functions and blocks could be considered as the additional essential functions and may differentiate one IRD from another:
 - Satellite tuner
 - Output interfaces
 - Operative system and applications
 - EPG
 - Service/system information (SI)
 - Conditional access (CA)
 - Display, remote control and different commands
 - Read only memory (ROM), random access memory (RAM) and FLASH memory
 - Interactive module
 - Microcontroller
 - Other functions as teletext, subtitling, etc.

3 Common elements of digital multiprogramme transmission systems

The common elements are as follows:

- Modulation/demodulation and error correction coding/decoding.
- Transport multiplex and demultiplex.
- Source encoding and decoding of video, audio and data.

3.1 Modulation/demodulation and coding/decoding

The block diagram of the modulation/demodulation and coding/decoding functions of the common elements is presented in Fig. 3. Overlapped blocks represent functions with common elements for the four systems although with different characteristics. Dashed blocks represent functions not utilized by all four systems.

3.1.1 Modulation and demodulation

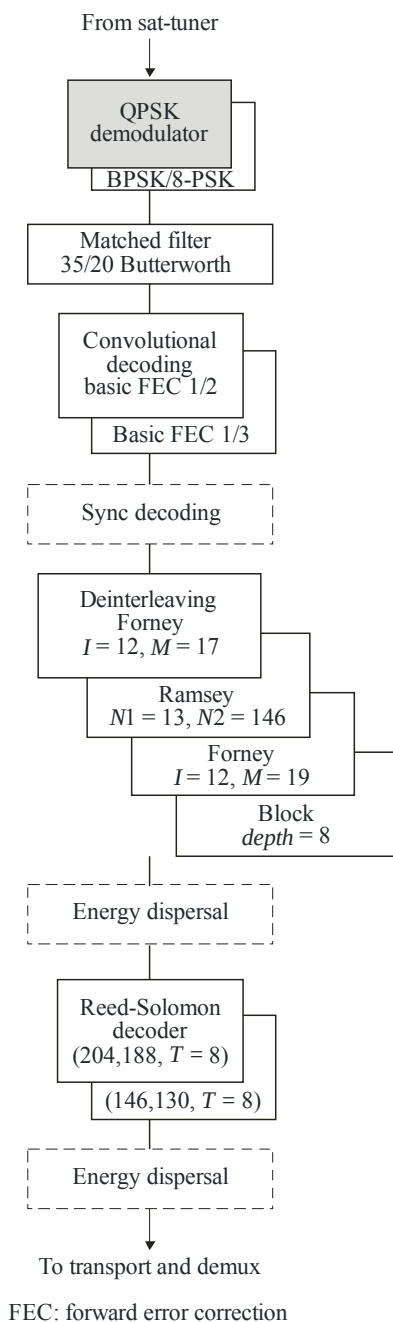
This common element performs the quadrature, binary or 8 phase coherent modulation and demodulation function. In the demodulator, the demodulator provides “soft decision” I and Q information to the inner decoder.

Within a satellite IRD this common element will be capable of demodulating a signal employing conventional Gray-coded QPSK modulation and TC 8-PSK modulation with absolute mapping (no differential coding).

For QPSK modulation, bit mapping in the signal as given in Fig. 4 will be used.

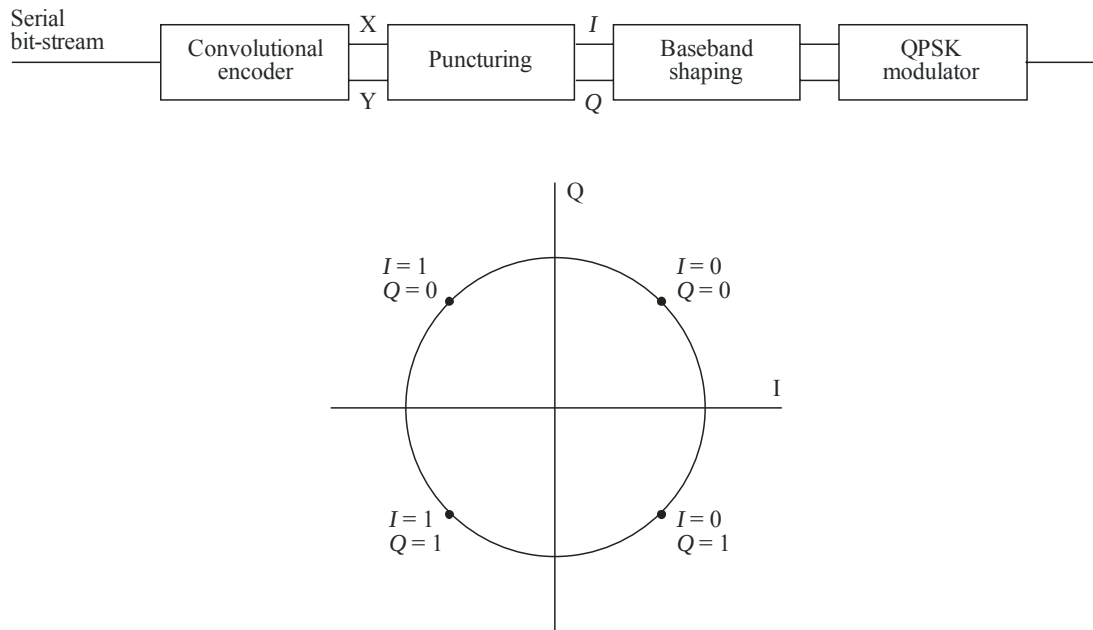
For the binary or 8-PSK modulation, bit mapping in the signal as described in § 5.2.4 will be used.

FIGURE 3

Block diagram for demodulation and channel decoding

BO.1516-03

FIGURE 4
QPSK constellation



BO.1516-04

3.1.2 Matched filter

This common element within the demodulator performs the complementary pulse shaping filtering type according to the roll-off. The use of a finite impulse response (FIR) digital filter could provide equalization of the channel linear distortions in the IRD.

The satellite IRD must be capable of processing the signal with the following shaping and roll-off factors:

Square root raised cosine:	$\alpha = 0.35$ and 0.20
Band-limited 4 th order Butterworth:	Standard and truncated-spectrum modes

Information about the template for the signal spectrum at the modulator output is given in § 5.1.

3.1.3 Convolutional encoding and decoding

This common element performs first level error protection coding and decoding. This element is designed such that the demodulator will operate at an input equivalent “hard decision” BER of the order of between 1×10^{-1} and 1×10^{-2} (depending on the adopted code rate), and will produce an output BER of about 2×10^{-4} or lower. This output BER corresponds to quasi-error free (QEF) service after outer code correction. It is possible that this unit makes use of “soft decision” information. This unit may be in a position to try each of the code rates and puncturing configurations until lock is acquired. Furthermore, it may be in a position to resolve $\pi/2$ demodulation phase ambiguity.

The inner code has the following characteristics:

- Viterbi and puncturing.
- Code constraint length $K = 7$.

The coder and decoder operate with three different convolutional codes. The system will allow convolutional decoding with code rates based on a rate of either 1/2 or 1/3:

- Based on a basic rate 1/2: FEC = 1/2, 2/3, 3/4, 5/6, 6/7 and 7/8.
- Based on a basic rate 1/3: FEC = 5/11, 1/2, 3/4, 2/3, 3/5, 4/5, 5/6 and 7/8.

Specific characteristics are provided in § 5.2.

3.1.4 Sync byte decoder

This common element will decode the sync bytes. The decoder provides synchronization information for the de-interleaving. It is also in a position to recover the phase ambiguity of the demodulator (not detectable by the Viterbi decoder).

Specific characteristics are provided in § 5.3.

3.1.5 Convolutional de-interleaver

This common element allows the error bursts at the output of the inner decoder to be randomized on a byte basis in order to improve the burst error correction capability of the outer decoder.

This common element utilizes Ramsey Type II ($N_1 = 13$, $N_2 = 146$) and Ramsey Type III (Forney approach) ($I = 12$, $M = 17$ and 19) convolutional interleaver systems or block interleaver system (depth = 8), as specifically defined in § 5.4.

3.1.6 Reed-Solomon coder and decoder

This common element provides second level error protection. It is in a position to provide QEF output (i.e. BER of about 1×10^{-10} and 1×10^{-11}) in the presence of input error bursts at a BER of about 7×10^{-4} or better with infinite byte interleaving. In the case of interleaving depth $I = 12$, $\text{BER} = 2 \times 10^{-4}$ is assumed for QEF.

This common element has the following characteristics:

- Reed-Solomon generator: (255,239, $T = 8$)
- Reed-Solomon code generator polynomial:

$$(x + \alpha^0)(x + \alpha^1) \dots (x + \alpha^{15})$$

or

$$(x + \alpha^1)(x + \alpha^2) \dots (x + \alpha^{16})$$

where:

$$\alpha = 02_{\text{h.}}$$

- Reed-Solomon field generator polynomial:

$$x^8 + x^4 + x^3 + x^2 + 1$$

Specific characteristics are provided in § 5.5.

3.1.7 Energy dispersal removal

This common element adds a randomizing pattern to the transmission to ensure even energy dispersal, which when present must be removed by the demodulator. It can be implemented in such a way as to be capable of derandomizing signals where the derandomizing process has been placed before or after the Reed-Solomon decoder. This common element of a satellite IRD may implement a bypass to this feature.

Specific characteristics are provided in § 5.6.

3.2 Transport and demultiplexing

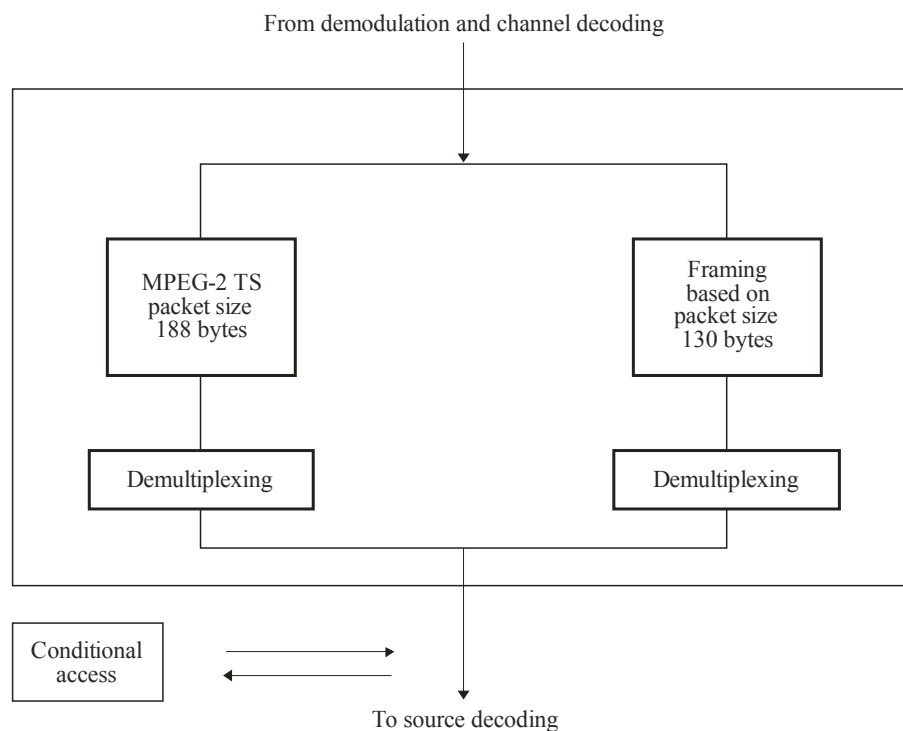
The block diagram of the transport and multiplex/demultiplex functions for the satellite IRD is presented in Fig. 5.

The system will be capable of receiving and demultiplexing packets following MPEG-2 transport multiplexer (see ISO/IEC 13818-1) as well as transport stream specific characteristics defined in § 5.7.

Conditional access is outside the scope of this Recommendation.

FIGURE 5

Block diagram for transport and demultiplexing

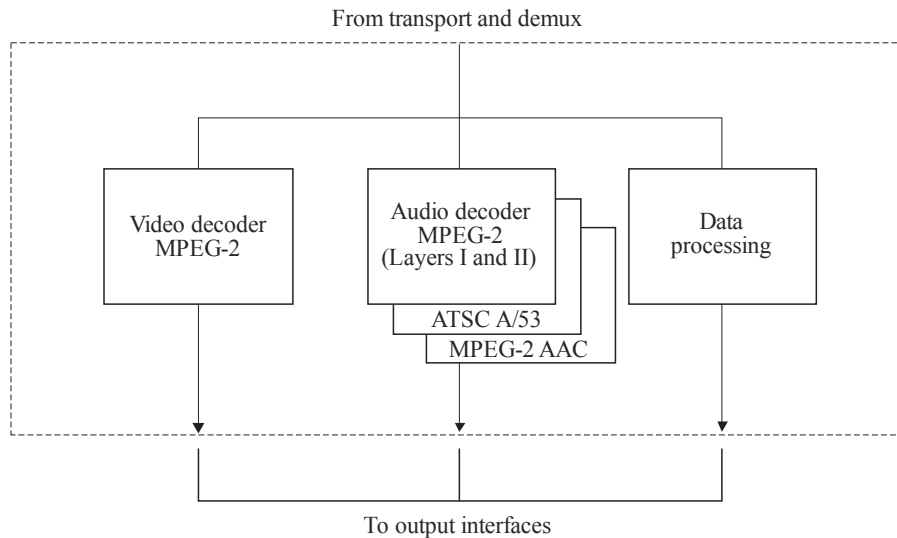


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3.3 Source coding and decoding of video, audio and data

The block diagram of the source encoding or decoding of video, audio and data functions is presented in Fig. 6.

FIGURE 6

Block diagram for source decoding

ATSC: Advanced Television Systems Committee

BO.1516-06

3.3.1 Video

This common element requires, as a minimum, the source coding and decoding of video formats following the main profile main level MPEG-2 signals as specified in ISO/IEC 13818-2.

3.3.2 Audio

This common element requires the source coding and decoding of audio signals following the MPEG-2 Layers I and II (ISO/IEC 13818-3), ATSC-A/53 Annex B (Recommendation ITU-R BS.1196, Annex 2) formats, and the MPEG-2 AAC (advanced audio coding) (ISO/IEC 13818-7).

3.3.3 Data

This block addresses the functions required to process source coded data delivered to or from the transport multiplex. This item is outside the scope of the Recommendation.

4 Summary characteristics and the comparison of digital multiprogramme TV systems by satellite

As described in the introduction, this Recommendation includes the characteristics of four digital multiprogramme TV systems that share the common elements described in section 3. These systems are identified as Systems A, B, C and D. System A was first described in Recommendation ITU-R BO.1211 and is also included in former Recommendation ITU-R BO.1294. Systems B and C were first described in former Recommendation ITU-R BO.1294. System D is described in Recommendation ITU-R BO.1408. Three of these systems are in operational use today, and the fourth is planned for operational deployment in the very near future.

These systems are designed to robustly deliver quality MPEG video and audio programming via digital satellite transmissions. The use of MPEG compression techniques provides very efficient use of the available spectrum, and the design of the transport layer allows very flexible assignment of video and audio programming to satellite transponders.

System A is based on the MPEG-2 video and sound coding algorithm and on the MPEG-2 transport multiplex. A concatenated FEC scheme using Reed-Solomon and convolutional coding, with soft-decision Viterbi decoding, allows very robust RF performance in the presence of noise and interference. Five coding rate steps in the range $1/2$ to $7/8$, offer different trade-offs between spectrum and power efficiency. The transmission symbol rate of the system can be chosen by the operator, to optimize the exploitation of the satellite transponder bandwidth.

System B is also based on the MPEG-2 main profile main level video coding algorithm. It uses the MPEG-1 Layer II audio syntax and the System B transport specification. As with System A, a concatenated FEC scheme using Reed-Solomon and convolutional coding, with soft-decision Viterbi decoding, allows very robust RF performance in the presence of noise and interference. Three coding rate steps in the range $1/2$ to $6/7$, offer different trade-offs between spectrum and power efficiency. The transmission symbol rate is fixed at 20 m symbols/s.

System C can also carry multiple digital television (and radio) services in time division multiplexed (TDM) format, and it shares the same common architectural elements as described above. The system includes renewable access control, impulse pay-per-view (IPPV), and data services. Virtual channels allow simplified viewer navigation and “surfing” between channels.

System D is a newly developed system designed for the broadcast of multimedia services. It integrates systematically various kinds of digital contents, each of which may include multiprogramme video from low definition television (LDTV) to high definition television (HDTV), multiprogramme audio, graphics, texts, etc. The proposed system can be integrated on the basis of MPEG-transport stream (MPEG-TS) which is widely used as a common container for digital contents.

In order to cover a wide range of requirements that may differ from one service to another, System D provides a series of modulation and/or error protection schemes that can be selected and combined flexibly. Introduction of multiple modulation/error correction schemes is especially useful for countries located in climatic zones experiencing high rain attenuation.

4.1 Summary system characteristics

Table 1 provides information on relevant parameters which characterize these four digital multiprogramme systems. The Table includes information on both core functions (common elements) as well as additional essential functions.

4.2 Comparison of system characteristics

The Radiocommunication Assembly in § 6.1.2 of Resolution ITU-R 1 states that: “When Recommendations provide information on various systems relating to one particular radio application, they should be based on criteria relevant to the application, and should include, where possible, an evaluation of the recommended systems, using those criteria.” Table 2 provides this evaluation. Performance criteria relevant to these systems were selected, and the associated parametric values or capabilities of each of these systems are provided.

TABLE 1

Summary characteristics of digital multiprogramme TV systems by satellite*a) Function*

	System A	System B	System C	System D
Delivered services	SDTV and HDTV	SDTV and HDTV	SDTV and HDTV	SDTV and HDTV
Input signal format	MPEG-TS	Modified MPEG-TS	MPEG-TS	MPEG-TS
Multiple input signal capability	No	No	No	Yes, 8 maximum
Rain fade survivability	Determined by transmitter power and inner code rate	Determined by transmitter power and inner code rate	Determined by transmitter power and inner code rate	Hierarchical transmission is available in addition to the transmitter power and inner code rate
Mobile reception	Not available and for future consideration	Not available and for future consideration	Not available and for future consideration	Not available and for future consideration
Flexible assignment of services bit rate	Available	Available	Available	Available
Common receiver design with other receiver systems	Systems A, B, C and D are possible	Systems A, B, C and D are possible	Systems A, B, C and D are possible	Systems A, B, C and D are possible
Commonality with other media (i.e. terrestrial, cable, etc.)	MPEG-TS basis	MPEG-ES (elementary stream) basis	MPEG-TS basis	MPEG-TS basis

TABLE 1 (continued)

b) Performance

	System A	System B	System C	System D
Net data rate (transmissible rate without parity)	Symbol rate (R_s) is not fixed. The following net data rates result from an example R_s of 27.776 Mbd: 1/2: 23.754 Mbits/s 2/3: 31.672 Mbits/s 3/4: 35.631 Mbits/s 5/6: 39.590 Mbits/s 7/8: 41.570 Mbits/s	1/2: 17.69 Mbits/s 2/3: 23.58 Mbits/s 6/7: 30.32 Mbits/s	19.5 Mbd 29.3 Mbd 5/11: 16.4 Mbits/s 24.5 Mbits/s 1/2: 18.0 Mbits/s 27.0 Mbits/s 3/5: 21.6 Mbits/s 32.4 Mbits/s 2/3: 24.0 Mbits/s 36.0 Mbits/s 3/4: 27.0 Mbits/s 40.5 Mbits/s 4/5: 28.8 Mbits/s 43.2 Mbits/s 5/6: 30.0 Mbits/s 45.0 Mbits/s 7/8: 31.5 Mbits/s 47.2 Mbits/s	Up to 52.2 Mbits/s (at a symbol rate of 28.86 Mbd)
Upward extensibility	Yes	Yes	Yes	Yes
HDTV capability	Yes	Yes	Yes	Yes
Selectable conditional access	Yes	Yes	Yes	Yes

c) Technical characteristics (Transmission)

	System A	System B	System C	System D
Modulation scheme	QPSK	QPSK	QPSK	TC8-PSK/QPSK/BPSK
Symbol rate	Not specified	Fixed 20 Mbd	Variable 19.5 and 29.3 Mbd	Not specified (e.g. 28.86 Mbd)
Necessary bandwidth (-3 dB)	Not specified	24 MHz	19.5 and 29.3 MHz	Not specified (e.g. 28.86 MHz)
Roll-off rate	0.35 (raised cosine)	0.2 (raised cosine)	0.55 and 0.33 (4 th order Butterworth filter)	0.35 (raised cosine)
Reed-Solomon outer code	(204,188, $T = 8$)	(146,130, $T = 8$)	(204,188, $T = 8$)	(204,188, $T = 8$)
Reed-Solomon generator	(255,239, $T = 8$)	(255,239, $T = 8$)	(255,239, $T = 8$)	(255,239, $T = 8$)

TABLE 1 (continued)

	System A	System B	System C	System D
Reed-Solomon code generator polynomial	$(x + \alpha^0)(x + \alpha^1) \dots (x + \alpha^{15})$ where $\alpha = 02_h$	$(x + \alpha^0)(x + \alpha^1) \dots (x + \alpha^{15})$ where $\alpha = 02_h$	$(x + \alpha^1)(x + \alpha^2) \dots (x + \alpha^{16})$ where $\alpha = 02_h$	$(x + \alpha^0)(x + \alpha^1) \dots (x + \alpha^{15})$ where $\alpha = 02_h$
Reed-Solomon field generator polynomial	$x^8 + x^4 + x^3 + x^2 + 1$	$x^8 + x^4 + x^3 + x^2 + 1$	$x^8 + x^4 + x^3 + x^2 + 1$	$x^8 + x^4 + x^3 + x^2 + 1$
Randomization for energy dispersal	PRBS: $1 + x^{14} + x^{15}$	None	PRBS: $1 + x + x^3 + x^{12} + x^{16}$ truncated for a period of 4 894 bytes	PRBS: $1 + x^{14} + x^{15}$
Loading sequence into pseudo random binary sequence (PRBS) register	100101010000000	N.A.	0001 _h	100101010000000
Randomization point	Before RS encoder	N.A.	After RS encoder	After RS encoder
Interleaving	Convolutional, $I = 12, M = 17$ (Forney)	Convolutional, $N1 = 13, N2 = 146$ (Ramsey II)	Convolutional, $I = 12, M = 19$ (Forney)	Block (depth = 8)
Inner coding	Convolutional	Convolutional	Convolutional	Convolutional, Trellis (8-PSK: TCM 2/3)
Constraint length	$K = 7$	$K = 7$	$K = 7$	$K = 7$
Basic code	1/2	1/2	1/3	1/2
Generator polynomial	171, 133 (octal)	171, 133 (octal)	117, 135, 161 (octal)	171, 133 (octal)
Inner coding rate	1/2, 2/3, 3/4, 5/6, 7/8	1/2, 2/3, 6/7	1/2, 2/3, 3/4, 3/5, 4/5, 5/6, 5/11, 7/8	1/2, 3/4, 2/3, 5/6, 7/8
Transmission control	None	None	None	TMCC
Frame structure	None	None	None	N slot/frame (e.g. N = 48) 8 frame/super frame

TABLE 1 (continued)

	System A	System B	System C	System D
Packet size	188 bytes	130 bytes	188 bytes	188 bytes
Transport layer	MPEG-2	Non-MPEG	MPEG-2	MPEG-2
Satellite downlink frequency range	Originally designed for 11/12 GHz, not excluding other satellite frequency ranges	Originally designed for 11/12 GHz, not excluding other satellite frequency ranges	Originally designed for 11/12 GHz and 4 GHz satellite frequency ranges	Originally designed for 11/12 GHz, not excluding other satellite frequency ranges

d) Example-technical characteristics (Source coding)

		System A	System B	System C	System D
Video source coding	Syntax	MPEG-2	MPEG-2	MPEG-2	MPEG-2
	Levels	At least main level	At least main level	At least main level	From low level to high level
	Profiles	At least main profile	At least main profile	At least main profile	Main profile
Aspect ratios		4:3 16:9 (2.12:1 optionally)	4:3 16:9	4:3 16:9	4:3 16:9
Image supported formats		Not restricted, Recommended: 720 × 576 704 × 576 544 × 576 480 × 576 352 × 576 352 × 288	720 × 480 704 × 480 544 × 480 480 × 480 352 × 480 352 × 240 720 × 1 280 1 280 × 1 024 1 920 × 1 080	720(704) × 576 720(704) × 480 528 × 480 528 × 576 352 × 480 352 × 576 352 × 288 352 × 240	1 920 × 1 080 1 440 × 1 080 1 280 × 720 720 × 480 544 × 480 480 × 480 352 × 240* 176 × 120* (* for hierarchical transmission)
Frame rates at monitor (per s)		25	29.97	25 or 29.97	29.97 or 59.94

TABLE 1 (*end*)

	System A	System B	System C	System D
Audio source decoding	MPEG-2, Layers I and II	MPEG-1, Layer II; ATSC A/53 (AC3)	ATSC A/53 or MPEG-2 Layers I and II	MPEG-2 AAC
Service information	ETS 300 468	System B	ATSC A/56 SCTE DVS/011	ETS 300 468
EPG	ETS 300 707	System B	User selectable	User selectable
Teletext	Supported	Not specified	Not specified	User selectable
Subtitling	Supported	Supported	Supported	Supported
Closed caption	Not specified	Yes	Yes	Supported

TABLE 2

Comparison characteristics table

Modulation and coding	System A		System B		System C		System D	
Modulation modes supported individually and on the same carrier	QPSK		QPSK		QPSK		8-PSK, QPSK, and BPSK	
Performance (define quasi-error-free (QEF) required C/N (bits/s/Hz))	Spectral efficiency	C/N for QEF ⁽¹⁾	Spectral efficiency	C/N for QEF ⁽²⁾	Spectral efficiency ⁽³⁾	C/N for QEF ⁽⁴⁾	Spectral efficiency	C/N for QEF ⁽⁵⁾
Modes Inner code								
BPSK Conv. 1/2	Not used		Not used		No		0.35	0.2

TABLE 2 (continued)

Modulation and coding		System A		System B		System C		System D	
QPSK Conv.	5/11	Not used		Not used		0.54/0.63	2.8/3.0	Not used	
	1/2	0.72	4.1	0.74	3.8	0.59/0.69	3.3/3.5	0.7	3.2
	3/5	No		Not used		0.71/0.83	4.5/4.7		
	2/3	0.96	5.8	0.98	5	0.79/0.92	5.1/5.3	0.94	4.9
	3/4	1.08	6.8	Not used		0.89/1.04	6.0/6.2	1.06	5.9
	4/5	Not used		Not used		0.95/1.11	6.6/6.8	Not used	
	5/6	1.2	7.8	Not used		0.99/1.15	7.0/7.2	1.18	6.8
	6/7	Not used		1.26	7.6	Not used		Not used	
	7/8	1.26	8.4	Not used		1.04/1.21	7.7/7.9	1.24	7.4
8-PSK Trellis		Not used		Not used		Not used		1.4	8.4
Capable of hierarchical modulation control?		No		No		No		Yes	
Symbol rate characteristics		Continuously variable		Fixed, 20 Mbd		Variable, 19.5 or 29.3 Mbd		Continuously variable	
Packet length (bytes)		188		130		188		188	
Transport streams supported		MPEG-2		System B		MPEG-2		MPEG-2	