RECOMMENDATION ITU-R SNG.1561

Digital transmission of high-definition television for satellite news gathering and outside broadcasting

(Question ITU-R 226/4)

(2002)

The ITU Radiocommunication Assembly,

considering

a) that in point-to-point video transmission via satellite, quality of service objectives are fixed on the basis of large sized transmitting and receiving station antennas;

b) that the introduction of highly portable transmitting stations is essential particularly for news gathering operations and can provide a satisfactory technical solution;

c) that the special characteristics needed for portable and transportable stations and the reduced link availability characteristics of highly portable stations may necessitate acceptance of reduced transmission performance objectives;

d) that it may be necessary to provide, on the same satellite bearer, the auxiliary signals required for the operation of portable and transportable transmitting stations but that these auxiliary signals should not have a perceptible effect on the transmission quality of the television signals;

e) that throughout the world, where news events take place, standardized and uniform technical and operating procedures should be established to ensure prompt activation of satellite news gathering (SNG) and outside broadcasting services;

f) that to facilitate the international coverage of news, it is necessary to adopt uniform operating parameters for high-definition television (HDTV) digital SNG, to ensure interoperability between equipment from different manufactures,

noting

a) that Recommendation ITU-R SNG.1007 provides uniform technical standards for SNG;

b) that Recommendation ITU-R SNG.1421 gives common operating parameters to ensure interoperability for transmission of digital conventional television SNG,

recommends

1 that when requiring international interoperability, the HDTV digital SNG equipment should comply with the uniform operating parameters described in Annex 1.

ANNEX 1

1 Scope

The system is based on the following technical requirements:

– The system should be applicable to all possible satellite transponders, including future planned ones.

– The source coding system should conform to the MPEG-2 systems[1].

– The channel coding system should be as flexible as possible, with the highest possible efficiency for the intended application. It should be selectable by the user according to the characteristics of the transmission channel.

– The user bit rate should meet the picture quality requirements which may be requested from other relevant ITU Study Groups.

– The information bit rate with outer coding should be defined, taking account of connectivity with existing international digital hierarchies as well as coding performance.

– The SNG system may include the auxiliary channels, such as communication channels.

2 Source encoding, service information and multiplexing

2.1 Video encoding

Video encoding in accordance with MPEG-2 4:2:2P@HL is recommended. The use of MPEG-2 MP@HL may also be considered.

Video source and bit rate (horizontal and vertical resolution) do not affect interoperability. These parameters are not specified in this Recommendation as integrated receiver decoders (IRD) should handle these automatically.

2.2 Audio encoding

Audio encoding to MPEG-1 Layers I and II, MPEG-2 Layers I and II, MPEG-2 AAC, or AC-3 should be used.

Audio channel configuration, source and bit rate do not affect interoperability. These parameters are not specified in this Recommendation as IRD should handle these automatically.

2.3 Data encoding

Subject for further study.

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[1] MPEG-2 refers to ITU-T Recommendations H.222 and H.262, or ISO/IEC 13818.

2.4 Program Specific Information (PSI) and Service Information (SI)

2.4.1 General

PSI and SI should conform to all relevant requirements in accordance with applicable standards and guidelines.

The following tables are mandatory for MPEG-2 digital video broadcasting using satellite (DVB-S) compliance:

PAT: Program Association Table

PMT: Program Map Table

CAT: Conditional Access Table

NIT: Network Information Table, actual delivery system

SDT: Service Description Table, (actual transport stream)

TDT: Time and Date Table

EIT: Event Information Table, present/following actual transport stream.

Some of these service information tables or their contents may not be relevant to digital SNG service, but they are still required.

This Recommendation does not specify values or syntax of the service information tables but recommends that wherever possible default values should be used by the equipment to facilitate simple and rapid deployment of digital SNG.

In digital SNG transmissions, editing of the SI tables in the field may be impossible due to operational problems. Therefore, only the following MPEG-2 defined SI tables PAT, PMT and SDT transport stream Service Description Table are mandatory.

2.4.2 First SDT descriptor

See Recommendation ITU-R SNG.1421.

2.4.3 Second SDT descriptor

See Recommendation ITU-R SNG.1421.

2.4.4 Guidelines

2.4.4.1 Guidelines for the usage of the SDT (transport stream Service Description Table) within digital SNG streams

SDTs are repeated at least every 10 s.

The station_identification_char field contains the following items, comma-separated and in the following order:

– usual station code;

– SNG headquarter;

– SNG provider.

The usual station code is the code assigned to the station by the satellite operator with which the station is most frequently used.

The SNG headquarter (operating during the transmission period) is the control centre through which the station can uniquely be identified (by giving its usual station code) and quickly located. The SNG provider is the owner of the SNG station.

IRDs should be flexible enough to handle at least the mandatory service information table, and intelligent enough to ignore optional service information that they have not been designed to utilize.

Digital SNG IRDs shall be able to decode and interpret the SDT and the descriptors specified.

2.4.4.2 Guidelines to achieve compatibility with consumer IRDs

If compatibility with consumer IRDs is required, the SDT shall contain three descriptors:

– The first descriptor is a transport stream descriptor [0x67] containing the ASCII string "DVB". The presence of this descriptor implies that all SI tables shall be present according to the DVB-SI specification.

– The second descriptor is the transport stream descriptor [0x67] containing the ASCII string "CONA". The presence of this descriptor indicates that the transmission is of contribution nature.

– For digital SNG transmissions, the third descriptor is the digital SNG descriptor [0x68].

2.5 Multiplexing

The system input stream is organized in fixed length packets, following the MPEG-2 transport multiplexer MUX (see ITU-T Recommendation H.222). The total packet length of the MPEG-2 transport multiplex packet is 188 bytes.

3 Transmission system

The system is defined as the functional block of equipment performing the adaptation of the baseband TV signal, from the output of the MPEG-2 transport multiplexer (see ITU-T Recommendation H.222), to the satellite channel characteristics.

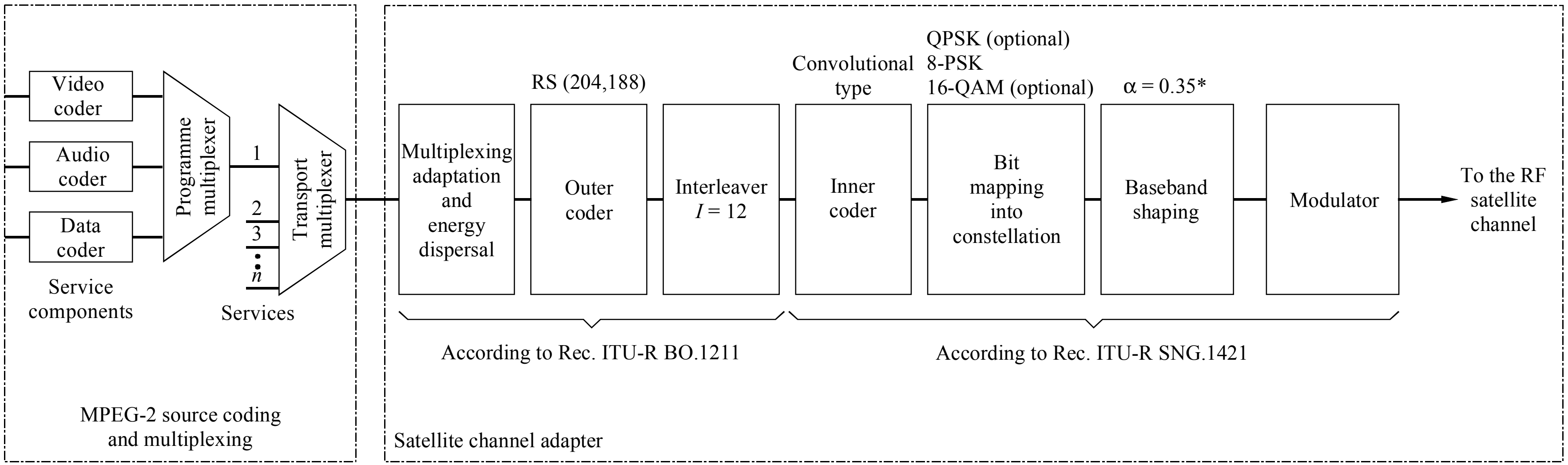
The system transmission frame is synchronous with the MPEG-2 multiplex transport packets (see ITU-T Recommendation H.222).

The system uses 8-phase shift keying (8-PSK) modulation, and optionally quadrature (QPSK) or 16-quadrature amplitude modulation (16-QAM) modulations, and the concatenation of convolutional and Reed-Solomon (RS) codes. For 8-PSK and 16-QAM, pragmatic trellis coding applies, optimizing the error protection of the convolutional code defined in Recommendation ITU-R BO.1211. The convolutional code is able to be configured flexibly, allowing the optimization of the system performance for a given satellite transponder bandwidth.

All the transmission systems are according to Recommendation ITU-R SNG.1421 (see Fig. 1).

FIGURE 1

Functional block diagram of the system



* $\alpha = 0.25$ for 8-PSK and 16-QAM (optional).

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The following processes are applied to the data stream (see Fig. 1):

– transport multiplex adaptation and randomization for energy dispersal (according to Recommendation ITU-R BO.1211);
– outer coding (i.e. RS) (according to Recommendation ITU-R BO.1211);
– convolutional interleaving (according to Recommendation ITU-R BO.1211);
– inner coding:
  – punctured convolutional coding (according to Recommendation ITU-R BO.1211);
  – pragmatic trellis coding associated with 8-PSK and 16-QAM (optional);
– bit mapping into constellations:
  – 8-PSK;
  – QPSK (optional);
  – 16-QAM (optional);
– squared-root raised-cosine baseband shaping:
  – roll-off factor $\alpha = 0.35$ according to Recommendation ITU-R BO.1211 for QPSK, 8-PSK and 16-QAM;
  – additional optional roll-off factor $\alpha = 0.25$ (for the modulations 8-PSK and 16-QAM);
– quadrature modulation (according to Recommendation ITU-R BO.1211).

If the received signal is above C/N and C/I threshold, the forward error correction technique adopted in the system is designed to provide a quasi-error-free (QEF) quality target. The QEF means less than one uncorrected error-event per transmission hour, corresponding to bit error ratio $= 1 \times 10^{-10}$ to 1×10^{-11} at the input of the MPEG-2 demultiplexer.

3.1 Adaptation to satellite transponder characteristics

The symbol rate is matched to given transponder characteristics, and, in the case of multiple carriers per frequency division multiplexing (FDM) transponder, to the adopted frequency plan. Examples of possible use of the system are given in Appendix 1.

3.2 Interfacing

See Recommendation ITU-R SNG.1421.

3.3 Channel coding

See Recommendation ITU-R SNG.1421.

3.4 Baseband shaping and quadrature modulation

See Recommendation ITU-R SNG.1421 taking into account that 8-PSK is the recommended modulation scheme.

3.5 Error performance

See Recommendation ITU-R SNG.1421 taking into account that 8-PSK is the recommended modulation scheme.

3.6 Transmission set-ups for emergency situations

At least one set of operating parameters should be defined for preset or default mode of operation.

4 Two-way communication channels

Subject for further study.

APPENDIX 1

TO ANNEX 1

Examples of possible use of the system

In single carrier per transponder configurations, the transmission symbol rate, R_s can be matched to given transponder bandwidth (BW) (at –3 dB), to achieve the maximum transmission capacity compatible with the acceptable signal degradation due to transponder bandwidth limitations. To take into account possible thermal and ageing instabilities, reference can be made to the frequency response mask of the transponder.

In the multi-carrier FDM configuration, R_s can be matched to the frequency slot, BS, allocated to the service by the frequency plan, to optimize the transmission capacity while keeping the mutual interference between adjacent carriers at an acceptable level.

Table 1 gives examples of the maximum useful bit-rate capacity R_u achievable by the system versus the allocated bandwidths BW or BS. The figures for very low and very high bit rates may be irrelevant for specific applications. In these examples the adopted BW/R_s or BS/R_s ratios are $\eta = 1 + \alpha = 1.35$, where α is the roll-off factor of the modulator. This choice allows to obtain a negligible E_b/N_0 degradation due to transponder bandwidth limitations, and also to adjacent channel interference on a linear channel. Higher bit rates can be achieved with the narrow roll-off factor $\alpha = 0.25$ (optional for 8-PSK and 16-QAM) and BW/R_s or BS/R_s equal to $\eta = 1 + \alpha = 1.25$.

Table 2 considers possible examples of use of the system in the single carrier per transponder configuration. Different modulation and inner code rates are given with the relevant bit rates. According to typical practical applications, a BW/R_s ratio equal to 1.31 is considered, offering a slightly better spectrum efficiency than the examples of Table 1 for the same modulation/coding schemes. The considered transponder bandwidth of 36 MHz is wide enough to allow high-quality 4:2:2P@HL single channel per carrier (SCPC) transmissions, as well as MP@HL and 4:2:2P@HL multiple channels per carrier (MCPC) transmissions.

Table 3 gives useful transmission set-up examples conformed for the use of BW/R_s ratio equal to 1.207.

TABLE 1

Examples of maximum bit rates versus transponder BW or BS, for BW/R_s or BS/R_s = η = 1.35 (applicable for HDTV)

BW or BS (MHz)	R_s = BW/1.35 (MBd)(1)	R_u (Mbit/s)(2)									
		QPSK					8-PSK			16-QAM	
		Rate 1/2	Rate 2/3	Rate 3/4	Rate 5/6	Rate 7/8	Rate 2/3	Rate 5/6	Rate 8/9(3)	Rate 3/4	Rate 7/8
72	53.333	49.1503	65.5338	73.7255	81.9172	86.0131	98.3007	122.876	131.068	147.451	172.026
54	40.000	36.8627	49.1503	55.2941	61.4379	64.5098	73.7255	92.1568	98.3007	110.588	129.020
46	34.074	31.4016	41.8688	47.1024	52.3360	54.9528	62.8032	78.5040	83.7376	94.2047	109.906
41	30.370	27.9884	37.3178	41.9826	46.6473	48.9797	55.9768	69.971	74.6357	83.9651	97.9593
36	26.666	24.5752	32.7669	36.8627	40.9586	43.0065	49.1503	61.4379	65.5338	73.725	86.0131
33	24.444	22.5272	30.0363	33.7908	37.5454	39.4227	45.0545	56.3181	60.0726	67.5817	78.8453
30	22.222	20.4793	27.3057	30.7190	34.1322	35.8388	40.9586	51.1983	54.6115	61.4379	71.6776
27	20.000	18.4314	24.5752	27.6471	30.7190	32.2549	36.8627	46.0784	49.1503	55.2941	64.5098
18	13.333	–	16.3834	18.4314	20.4793	21.5030	24.5752	30.7190	32.7669	36.8627	43.0065
15	11.111	–	–	–	17.0661	17.9194	24.5752	25.5991	27.3057	30.7190	35.8388
12	8.888	–	–	–	–	–	16.3834	20.4793	21.8446	24.5752	28.6710
9	6.666	–	–	–	–	–	–	–	16.3834	18.4314	21.5033

(1) BW/R_s or BS/R_s ratios different from $1 + \alpha$ may be adopted for different service requirements. The adoption of BS/R_s figures significantly lower than $1 + \alpha$ (e.g. BS/R_s = 1.207 associated with $\alpha = 0.35$), to improve the spectrum exploitation, should be carefully studied on a case-by-case basis, since severe performance degradations may arise due to bandwidth limitations and/or adjacent channel interference, especially with 8-PSK and 16-QAM modulations and high coding rates (e.g. 5/6 or 7/8).

(2) R_u stands for the useful bit rate (188-byte format) after MPEG-2 MUX. R_s (symbol rate) corresponds to the –3 dB bandwidth of the modulated signal. R_s $(1 + \alpha)$ corresponds to the theoretical total signal bandwidth after the modulator.

(3) 8-PSK rate 8/9 is suitable for satellite transponders driven near saturation, while 16-QAM rate 3/4 offers better spectrum efficiency for quasi-linear transponders, in frequency division multiple access configuration.

TABLE 2

Examples of system configurations by satellite: single carrier per transponder

Satellite BW (at –3 dB) (MHz)	System mode	Symbol rate R_s (MBd)	Bit rate R_u (after MUX) (Mbit/s)	E_b/N_0(1) (specification) (dB)
36	QPSK rate 3/4	27.500	38.015	5.5
36	8-PSK rate 2/3	27.500	50.686	6.9

(1) The E_b/N_0 figures refer to the IF loop specification for QEF. Overall linear, non-linear and interference performance degradations by satellite should be evaluated on a case-by-case basis; typical figures are of the order of 0.5 to 1.5 dB.

Quasi-constant envelope modulations, such as QPSK and 8-PSK, are power efficient in single carrier per transponder configuration, since they can operate on transponders driven near saturation. Conversely, 16-QAM is not power efficient since it can only operate on quasi-linear transponders (i.e. with large output-back-off (OBO)). The use of the narrow roll-off $\alpha = 0.25$ with 8-PSK can produce a larger non-linear degradation by satellite.

TABLE 3

Transmission set-up examples

BW or BS (MHz)	R_s = BW/1.207 (MBd)	R_u (Mbit/s)							
		QPSK					8-PSK		
		Rate 1/2	Rate 2/3	Rate 3/4	Rate 5/6	Rate 7/8	Rate 2/3	Rate 5/6	Rate 8/9
27	22.368	20.6136	–	30.9205	–	–	41.2273	–	–
36	29.824	27.4849	–	41.2273	–	–	54.9697	–	–

Table 4 considers possible examples of use of the system in the multi-carrier FDM configuration and in SCPC mode. Different modulation/coding modes are given with the relevant bit rates.

TABLE 4

Examples of system configurations by satellite: multi-carrier FDM transmissions, SCPC mode

Satellite BW (MHz)	Slot BS (MHz)	Number of slots in BW	Video coding	System mode	Symbol rate (MBd)	BS/R_s (Hz/Bd)	Bit rate R_u (Mbit/s)	E_b/N_0 (1) (specification) (dB)
36	18	2	4:2:2P@HL	QPSK rate 7/8	13.3332	1.35	21.5031	6.4
36	12	3	4:2:2P@HL	8-QPSK rate 5/6	9.3332	1.28	21.5030	8.9
36	9	4	4:2:2P@HL	16-QAM rate 7/8	6.6666	1.35	21.5030	10.7
72	18	4	4:2:2P@HL	QPSK rate 7/8	13.3332	1.35	21.5031	6.4

(1) The E_b/N_0 figures refer to the IF loop specification for QEF. Overall linear, non-linear and interference degradations by satellite should be evaluated on a case-by-case basis; typical figures are of the order of 0.5 dB to 1.5 dB.

In the FDM configuration, the satellite transponder must be quasi-linear (i.e. with large OBO) to avoid excessive intermodulation interference between signals. Therefore 16-QAM may be used.

The system, when operating in 8-PSK and 16-QAM modes, is more sensitive to phase noise than in QPSK modes.