EUROVISION

The 34 Mbit/s – 8PSK coding system planned for Eurovision

L. Cheveau (EBU)

After presenting a reminder of how the 34/45 Mbit/s digital coding standard was developed by the European and international bodies (ETSI and the ITU respectively), the Author describes the specific requirements of Eurovision – firstly as regards interference with analogue signals and, secondly, with respect to the optimization of the capacity leased by Eurovision on the Eutelsat system. These requirements have led to the adoption of 8PSK modulation.

All the intensive studies and tests involved were conducted over a period of six years during which there was exemplary co-operation between EBU Members and European manufacturers.

1. Introduction

Until the mid-1980s, digital television coding experts were generally of the opinion that contribution applications required a bit-rate of 140 Mbit/s whereas lower rates (34 Mbit/s in Europe and 45 Mbit/s in America) could be used for broadcasting. It was only in 1990 that the idea of using 34 Mbit/s on the Eurovision network became widely accepted; it was understood that, while 140 Mbit/s codecs would continue to be used for local or national applications, they would no longer be considered for use on the Eurovision network.

2. Development of the 34 Mbit/s standard

At this stage, efforts to standardize a 34 Mbit/s system had proved unsuccessful within both the ITU and the EBU.

In spring 1990, the EBU Technical Committee approved a recommendation in favour of using a 34 Mbit/s system for Eurovision. The system should be standardized internationally – before summer 1990 if possible – but, failing that, any decision on a system should be based on the lowest price.

In June 1990, the ETSI Network Aspects (NA) Committee proposed a working method (based notably on votes made by the national standardization bodies) in an attempt to get things moving on the 34 Mbit/s front. A particular obstacle at that stage was that a choice would have to be made from three different coding algorithms and between two different multiplexing proposals. At an extraordinary meeting, the ETSI NA Committee recommended that efforts be pursued to find a compromise solution and it asked the EBU to organize the meetings of the ETSI coding experts

Original language: French
Manuscript received 14/8/96.

group, by providing a chairman (Nick Lodge, ITC) and the secretariat.

It may seem strange to off-load responsibility in this way but, in fact, after three meetings (28 September, 4 October and 8 October 1990), a compromise solution was finally accepted by the group: it opted for the algorithms proposed by Telettra (which became Alcatel Telettra around the same time) and the multiplexing principle proposed by Thomson, based on 125 µs (8 kHz) frames that would be compatible with future SDH and ATM developments.

At its meeting in November 1990, ETSI NA adopted this compromise solution and asked the EBU to continue organizing the meetings of the ETSI coding experts group, until a draft ETS document had been produced. The first version of this document was officially presented to the Bureau of the EBU Technical Committee in February 1991, and to both ETSI and the CMTT/2 Committee of the ITU in March 1991.

From this moment on, the standard was to bear the reference ETS 300 174 [1] within ETSI and the reference CMTT 723 within the ITU. However the final ITU version – CMTT 723-1 (1992) – was never published under this reference. Instead, it was published under the reference J.81 because, following an in-depth reorganization within the ITU, the CCIR, CMTT, CCTT and IFRB all disappeared and were replaced by two sectors, ITU-R and ITU-T. The full ITU reference of the standard is thus: ITU-T J.81 [2].

A first accelerated-approval procedure was organized within ETSI at the end of 1991. Of the replies received by 2 December 1991 (98 %), the proposed document was accepted by 97.3 %. However, another year went by before final approval (vote No. 26) was obtained; definitive publication of the standard took place in November 1992.

In fact, while the finishing touches to editorial changes were being made at the EBU before publication of the standard, CMTT/2 was organizing a series of objective and subjective measurements with a first prototype codec supplied by Telettra. The results of these tests were encouraging and satisfactory from all points of view, except one. Although the codec met requirements vis-à-vis *random errors* up to a level higher than 5.10^{-4}, it did not meet the requirements of resistance to *error bursts* (which occur regularly on satellite links which use modems of the Intelsat IDR type). Once again, a compromise solution was accepted in June 1992: the interleaving of the Reed-Solomon (R-S) code applied to the video signal was increased from 2 to 6.

A brief description of the ETS 300 174 / ITU-T J.81 standard is given in *Table 1*.

3. EBU / Eurovision interfaces of the 34 Mbit/s codec

The 34 Mbit/s standard was defined only for a digital signal which conforms with ITU-R Recommendation BT.601 [3]. In particular, the interfaces with analogue systems and the audio characteristics were not specified.

These characteristics and other requirements specific to Eurovision were defined by EBU Working Group T/ESP (External Specifications), chaired by Mr. A. Weisser (TDF).

This new set of specifications was also drawn up in consultation with the manufacturers, taking account of their comments and of the Eurovision requirements that were known in 1992-1993. It will be recalled that, at that time, the network was still mainly terrestrial with only two transponders on Eutelsat I; from January 1993, however, the network capacity was increased to four leased transponders on Eutelsat II.

The manufacturers that were interested in developing this kind of equipment were working in very close contact – not only with the EBU but also among themselves – and it is largely due to their excellent co-operation that it was possible to develop compatible high-performance equipment.

These specifications were published in **EBU Technical Review** No. 258 (Winter 1993) [4] and were communicated in a call for tenders issued in early 1994. Without fail, the bids had to be accompanied by a reference model, delivered by 29 April 1994 at the latest (i.e. 18 months after publication of the ETSI standard). Three manufacturers submitted their equipment by this date: Alcatel Telettra (Italy), RE (Denmark) and Thomson (France).

In December 1994, the EBU was able to issue a press release (PR 18/94) announcing that total interoperability of the available equipment had been achieved at the 4:2:2 level of ITU-R Recommendation BT.601 [3]. However, a few problems still remained regarding the analogue IDS and ITS interfaces.

Table 1
Brief details of the ETS 300 174 / ITU-T J.81 standard.

Function		Specification / value
Video input/ output	Standard	525-line or 625-line digital video in component form. Manual or automatic selection of the video standard is at the manufacturer's discretion *(note 1)*
	Coding	4:2:2 level of ITU-R Recommendation BT.601
	Interfaces	Bit-serial (10-bit, 270 Mbit/s serial interface). Bit-parallel interfaces to ITU-R Recommendation BT.656 shall also be provided.
Signal pre-processing	Horizontal	Full digital active line of 720 samples for the luminance (Y) and 360 samples for each of the colour-difference signals (C_R, C_B).
	Vertical	525-line – 248 lines per field *(note 2)* Field 1: lines 16 to 263 Field 2: lines 278 to 525 625-line – 288 lines per field Field 1: lines 23 to 310 Field 2: lines 336 to 623
	Numerical representation	Digital input samples of Y, C_R and C_B conform to ITU-R Recommendation BT.601 numerical range. These samples are converted to an 8-bit 2's complement representation for the purpose of processing within the codec.
Coding	Modes	Three modes (intra-field, inter-field and motion compensated inter-frame) are used. The following three processing operations are applied either on 8 x 8 intra-field blocks (intra-field mode) or on differential blocks obtained from the difference between the current 8 x 8 intra-field block and a reference block taken in the previous field (inter-field mode) or in the field with the same parity in the previous frame (inter-frame mode).
	DCT	Discrete Cosine Transform applied on rectangular blocks of 8 lines of 8 samples for the three components Y, C_R, C_B.
	Prediction of the block	For each block processed according to inter-field mode, the reference block is determined with pixels of the previous field without motion compensation. For each block processed according to inter-frame mode, the reference block is taken from the position of the current block by application of a displacement vector.
	Motion compensation	Motion compensation is applied to "macro-blocks". Each macro-block (two adjacent 8 x 8 blocks for Y and the two co-positioned blocks, C_R and C_B) is assigned a single displacement vector with a half-pixel accuracy.
	Quantization	A different quantization characteristic is used for each coefficient. Its parameters are adapted to the buffer occupancy, the type of block (luminance/ chrominance), and the criticality of the block. The shape of the characteristic is nearly uniform.
	Variable length coding	VLCs are used to encode the quantized DCT coefficients and motion information.
Buffer memory capacity		1 572 864 bits.
Video data error protection		Reed-Solomon (255, 239), interleaving factor 6.
Service multiplex		This combines: – a video channel – 2048 kbit/s (or 1544 kbit/s) audio channel(s) *(note 3)* – 384 kbit/s teletext channel(s) – 128 kbit/s test-line channel – 8 kbit/s supervision channel – two 8 kbit/s conditional access channels – two 8 kbit/s time code channels
Network adaptation		Adaptation to ITU-T Recommendations G.751 and G.752, and to ITU-T Recommendations G.707, G.708 and G.709 which relate to SDH.
Scrambling for conditional access		Three modes: – without – with local key words – with centralised management

Note 1: This codec can accommodate the transmission of PAL/SECAM/NTSC by means of optional encoders and decoders.

Note 2: Only 244 lines per field are significant; lines 16, 17, 18, 19 and 278, 279, 280, 281 are encoded but not displayed.

Note 3: Neither the coding nor the error protection of the audio channels is covered by this Recommendation.

The interoperability tests and successive improvements – up to the beginning of 1996 – are set out in detail in the article beginning on *page 24* of this issue [5].

In summer 1996, the EBU Operations Department redefined the minimum functions of a codec for Eurovision. If the EBU user requirements given at the end of this article are compared with the similar requirements published three years earlier [4], it will be seen that the differences are minimal and that the present user requirements in fact constitute a sub-set of those defined previously, i.e. these are slightly more "open" than the preceeding ones.

Abbreviations

8PSK	Eight-phase-shift keying
ATM	Asynchronous transfer mode
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
CMTT	Joint Study Group for Television and Sound Transmissions (CCIR/CCITT)
CNCT	National technical co-ordination centre
EIRP	Effective isotropic radiated power
ETSI	European Telecommunication Standards Institute
EVC	Eurovision Control Centre
G/T	Gain/temperature ratio
IDR	Intermediate data rate
IDS	Insertion data signal
IFRB	International Frequency Registration Board
ISO	International Standards Organisation
ITS	Insertion test signal
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union, Radiocommunication Sector
ITU-T	International Telecommunication Union, Telecommunication Standardization Sector
MPEG	Moving Picture Experts Group (ISO)
QPSK	Quadrature (quaternary) phase-shift keying
R-S	Reed-Solomon
SDH	Synchronous digital hierarchy
SNG	Satellite news gathering

4. Modems

One of the first decisions taken in connection with network digitalization was to limit it to satellite routings, in other words those using transponders leased from Eutelsat. The tendency was to favour utilization of the space sector and earth stations, to the detriment of the terrestrial sector. This trend has become even more pronounced in recent years, so much so that it is difficult to imagine it being reversed until new technologies (optical fibres, ATM, etc.) become available at competitive prices.

4.1. QPSK modulation

It was therefore crucial to choose a modulation system suitable for the satellite. In the early 1990s, there was virtually no equipment on the market and the only standard was Intelsat IESS-308 [6], based on QPSK modulation with bit-rates ranging from 64 kbit/s to 45 Mbit/s.

In 1991, the EBU Technical Department acquired a pair of EF Data (USA) SDM 450 modems which were the only ones available at that time; the price was extremely high (CHF 90,000 with the overhead framing module). The studies conducted with these modems proved the feasibility of the 34 Mbit/s – QPSK solution, and the working parties got down to the task of developing a theoretical prediction model for calculating link budgets, including interference and various contributions to noise on the link.

The model developed for the EBU is still in use throughout the world, despite its weaknesses: its forecasts are often pessimistic and its extension to other bit-rates is sometimes tricky.

In 1992, a second modem manufacturer, Alcatel-Telspace (France), made available to the EBU the prototype of a 34 Mbit/s modem conforming to IESS-308 [6]. Interoperability tests were successfully carried out in October 1992 at the Rambouillet station near Paris, with the assistance in particular of TDF and Eutelsat.

The following year a third manufacturer, Newtec (Belgium), announced a new range of smaller 34 Mbit/s modems (2U high instead of 6U) and asked the EBU to check their interoperability. Subsequent tests proved both the reliability and the interoperability of these modems (following a minor modification by EF Data to their modem design).

About this time, the price of 34 Mbit/s – QPSK modems dropped considerably (to around CHF 15,000).

Intensive use of these QPSK modems made it possible to finalize the frequency plans in which four television channels (each at a bit-rate of 34 Mbit/s) could be accommodated per pair of transponders, compared with three channels under the analogue system.

Since some 34 Mbit/s codecs were able to multiplex two television channels, this facility was used in certain specific cases, such as:

- the Washington/New York → Europe link on Intelsat (i.e. the Transatlantic Television Channel, as of 1994);
- the Atlanta Olympic Games in 1996 (four 2 x 17 Mbit/s links, plus a special 16:9 link).

4.2. 8PSK modulation

In 1995, EF Data contacted the EBU to propose their new SDM 9000 series of 34 Mbit/s – QPSK modems. EF Data claimed that this new series of modems performed better than earlier models, were cheaper and, moreover, the new modems also offered an 8PSK modulation option that was more efficient than QPSK.

Tests conducted from June 1995 to the end of that year proved that 8PSK modulation offers a considerable increase in capacity over QPSK (three 34 Mbit/s channels per transponder instead of two) in return for a loss of no more than 2 to 3 dB in the link budget.

Since the earth stations on the Eurovision network are designed to handle analogue systems, they have enough reserve power to operate with 8PSK modulation. These stations would in fact have been over-powered with the QPSK system; choosing 8PSK therefore will also serve to optimize the network's existing resources.

As already mentioned, the prediction model developed by the EBU for calculating link budgets was a phenomenological model based on tests with 34 Mbit/s – QPSK. Theoretical work was required to evolve a reliable prediction tool that is valid for 8PSK modulation.

This work was carried out by RAI in Italy and is described in the article starting on *page 30* [7].

Work on the international standardization of 8PSK modulation is under way at Intelsat and the new standard bears the reference IESS-310 [8]. The main characteristics are as follows:

- pragmatic trellis coding;
- FEC = 2/3;
- outer Reed-Solomon code (219, 201, 9), interleaving factor 8.

In 1996, NEC announced it would produce 8PSK modems and intends to submit a bid which meets the EBU's requirements.

5. Validation phase

By the end of 1995, the EBU Technical Department had conclusively proved the feasibility of the 34 Mbit/s – 8PSK system.

It only remained to carry out a field trial of the system in an operational environment. This phase was conducted, at the request of the EBU Operations Department, during the first half of 1996. The aim was to show the qualities of (as well as any faults in) the 34 Mbit/s – 8PSK system, within the operational framework of the Eurovision network. The system had previously been tested and proved in the laboratory and field trials had been carried out with the earth stations at Vernier (Geneva), Zurich and Frankfurt.

The main findings of the operational phase were:

- it confirmed that the excellent results obtained during the technical tests could be reproduced at more than ten points on the network, under normal operating conditions;
- it confirmed that the earth station specifications of EBU document Tech. 3265 [9] were adequate for the proposed system;
- the interoperability of the four sets of 34 Mbit/s coding equipment was amply demonstrated, as the various units under test were statistically and geographically dispersed.

It will be recalled that the Eurovision earth stations have been designed to operate under the following reference conditions, defined in EBU document Tech. 3265 [9]:

- EIRP = 71 dBW on the satellite contour: G/T = –0.5 dB/K;
- antenna G/T = 35 dB/K on the satellite contour: EIRP = 42.5 dBW.

As an example, the relevant G/T and EIRP values relating to the Eurovision earth station at Vernier (Geneva) and the 3.70 m receiving dish at the EBU headquarters in Geneva are given in *Fig. 1*.

It goes without saying that a series of intensive tests conducted over several months and involving at least a dozen different countries could not be carried out without some technical problems occurring. These are described below.

a) 70-MHz input

Technical problems were encountered in a few cases where the station was not in conformity with the specification given in EBU document Tech. 3265 [9].

In Jerusalem, it was impossible to connect the equipment as this station has no 70 MHz input; instead, there is a compact transmit block which comprises a modulator plus converter. A special solution must be found for this station and other similar ones (Amman and Athens for instance).

b) Phase noise

Some stations which were not correctly aligned or which were using defective equipment had to be corrected in order to take part in the tests. This was the case with London, Nittedal (Norway) and SUI-1 (Switzerland).

Regarding the mobile earth station SUI-1, the converter was defective and the back-up converter had to be used. In Nittedal, there was a similar difficulty. There is still a problem with this station as the spectrum of the transmitted signal is not within the standard.

c) Distance from the station

Owing to the short notice and the limited duration of the tests, the equipment was often installed near the station itself. It was only in Geneva that there was a 34 Mbit/s link (approx. 4 km) between the EVC and the Vernier station. The situation at KLIN (80 km from Moscow) required travel backwards and forwards between the CNCT and the station, and the tests were still going on at the time of writing this article in August 1996.

d) Utilization of the modem's Reed-Solomon code

As it is probable that Intelsat will standardize on the use of 8PSK modulation with Reed-Solomon codes, the tests were conducted using this configuration. The technical tests, however, had shown that this configuration has no added advantage over the use of the 34 Mbit/s ETSI system, which already contains its own R-S correction system. On one occasion, putting the modem's R-S codec out of action paradoxically improved the situation in Nittedal and Stockholm!

e) Small transportable (SNG) stations

During the validation phase, small transportable (SNG) stations with antennas of approximately 1.80 m were used on two occasions. They were located in Brussels and Geneva (SUI-01). In both cases their use caused no difficulty. In fact, the power required for these stations was 65 dBW and their capacity was 66 and 73 dBW respectively, which provided the necessary margin to avoid the phenomenon of spectrum regeneration. It is obvious that the situation would not be so advantageous if similar stations had to transmit on the fringe of the satellite footprint (where the gain loss compared with the centre of the beam is of the order of 4 or 5 dB).

f) Reception with small antennas

On several occasions, reception was also evaluated with the small 3.70 m antenna at the EBU headquarters in Geneva, which is situated in the centre of the beam. Under these conditions, the system's margin was reduced by 3 to 4 dB which did not pose any problem. Reception was even possible when the transmission was made from the SNG antenna on the SUI-01 vehicle in Geneva. It goes without saying that such an operation, although

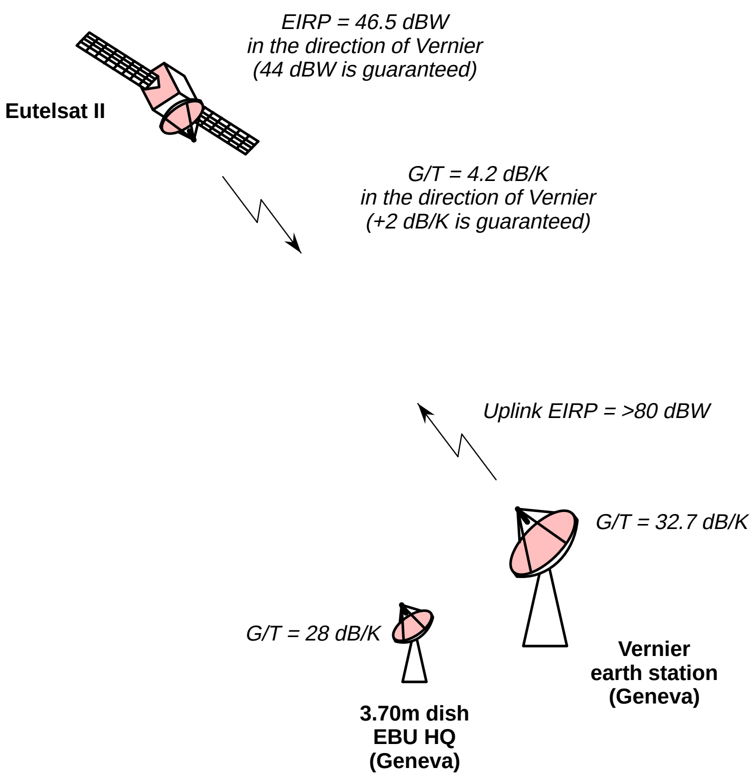


Figure 1
G/T and EIRP values relating to the Eurovision earth station at Vernier (Geneva) and the 3.70 m receiving antenna at EBU headquarters in Geneva.

feasible in Geneva, would not be possible on the fringe of the coverage area.

6. Conclusions

Between summer 1990 and summer 1996, the EBU made intensive efforts to define a high-performance digital modulation system, adapted to the requirements of Eurovision. During these six years, there were many upheavals – some of which have delayed the network digitalization process.

Particular mention should be made of the recent EBU restructuring. This has resulted in Eurovision activities being reorganized in the form of a profit centre in a bid to cope with the competitive situation today, which was virtually non-existent in 1990.

We must also not forget the technological progress that has been made recently in the area of digital compression, particularly within the framework of the MPEG standard and the DVB activities. Even if the DVB activities for the time being are focused mainly on applications intended for the general public, their potential impact for contribution applications must be assessed. To date, the very high cost of transmission equipment (the coder and the modulator) and its complexity have ruled out DVB technology for applications such as the Eurovision exchanges and SNG.

Lastly, the advantages of 8PSK modulation – a new technology which has been available for less than two years – makes it possible to optimize the transponder occupancy.

It was in the light of all these developments that the Council decided at its July 1996 meeting to:

– accept the principle of network digitalization within a (stated) maximum cost;
– accept that various manufacturers should be advised to submit their proposals for network digitalization, including suggestions for equipment and technology, which meet the network requirements and quality criteria laid down by the EBU;
– ask the Operations Department management to report to the Network Finance Policy Group on the results of these consultations with manufacturers and of the tests carried out with the various options, and to entrust this Group with submitting a proposal to the December 1996 Administrative Council on the choice to be made for network digitalization.

The aim is to complete network digitalization by the beginning of 1998.

Bibliography

[1] ETS 300 174: **Network Aspects (NA); Digital coding of component television signals for contribution quality applications in the range 34 – 45 Mbit/s**
ETSI, November 1992.

[2] ITU-T J.81: **Transmission of component-coded digital television signals for contribution-quality applications at the third hierarchical level of ITU-T Recommendation G.702**
International Telecommunication Union, September 1993.

[3] ITU-R Recommendation BT.601-4: **Encoding parameters of digital television for studios**.

[4] Cheveau, L. and Miles, R.: **Digitization of the Eurovision network**
EBU Technical Review No. 258, Winter 1993.

[5] Flowers, B.G.: **Interworking tests on 34 Mbit/s codecs**
EBU Technical Review No. 269, Autumn 1996.

Dr. Louis Cheveau *qualified as a Physics Engineer from the University of Liège, Belgium, in 1967and obtained a Ph.D. in Physics from the University of Montreal, Canada, in 1974. That year, he joined the EBU Technical Centre in Brussels as head of the computing department and, initially, worked in the field of terrestrial television broadcasting. In 1977, the emphasis of his work changed to satellite broadcasting.*

In 1984, Dr. Cheveau was detached for two years to the CBC in Canada. There, he worked in International Relations with special emphasis on satellite broadcasting and HDTV matters. In 1986, he returned to the EBU Technical Centre in Brussels, this time to work on Eurovision transmissions.

Since 1989, Dr. Cheveau has been Head of Transmission Technologies in the EBU Technical Department in Geneva.

[6] IESS-308: **Performance characteristics for Intermediate Data Rate (IDR) digital carriers (Standards A, B, C, E, and F earth stations)**
Intelsat, August 1994.

[7] Morello, A. and Visintin, M.: **Transmission of TC-8PSK digital television signals over Eurovision satellite links – system evaluation and optimization**
EBU Technical Review No. 269, Autumn 1996.

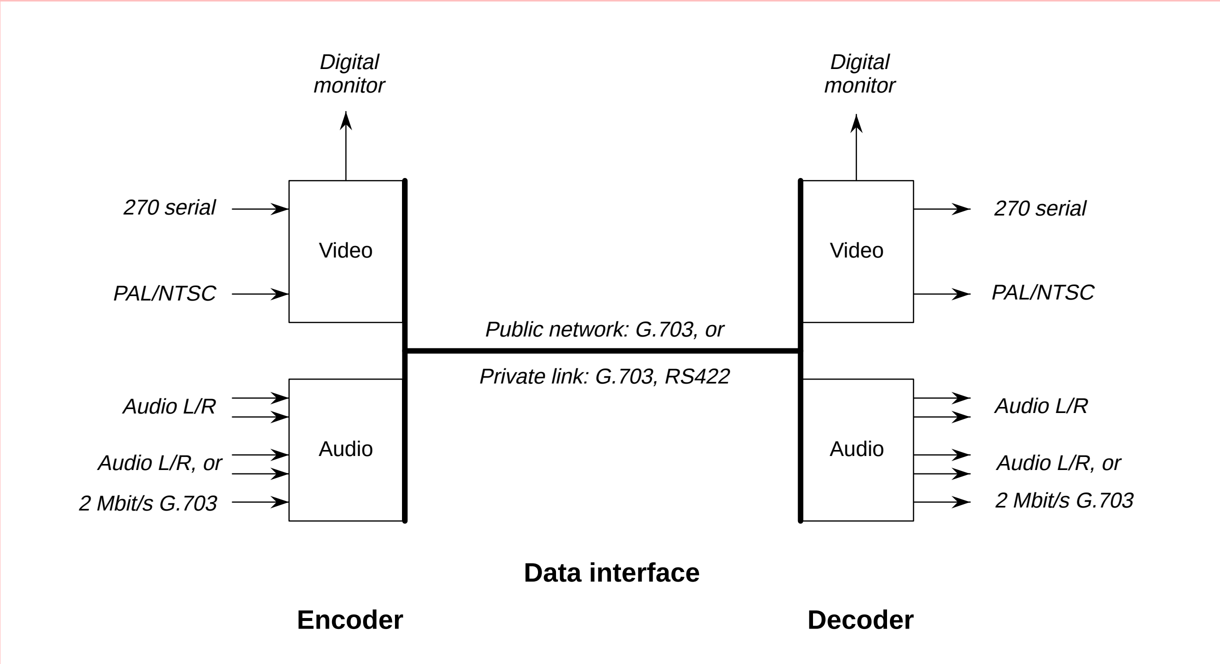
[8] IESS-310: **Performance characteristics for Intermediate Data Rate digital carriers using rate 2/3 TCM/8PSK and Reed-Solomon outer coding (Standards A, B, C, E, and F earth stations)**
Intelsat, September 1996.

[9] EBU document Tech.3265 (2nd edition, 1994): **Essential characteristics for a EUTELSAT II earth station (transmitting and receiving) having the minimum required performance for EUROVISION.**

EBU user requirements for digital television codecs

Interfaces

The main codec interfaces required are illustrated below:



The interfaces shall conform to the following guidelines:

Video inputs

The following video interfaces shall be available on the coder:

Digital Serial:	ITU-R Rec. BT.656 4:2:2 YC_rC_b
Analogue Composite:	625 line composite PAL as in Appendix to ITU-R Rec. BT.470-3 (formerly Report 624.4) switchable to 525-line NTSC-M as in the Appendix to ITU-R Rec. BT.470-3 (formerly Report 624.4)
Video monitor out:	Digital ITU-R Rec. BT.656 4:2:2

Video outputs

The following video outputs shall be available from the decoder:

Digital Serial:	ITU-R Rec. BT.656 4:2:2 YC_rC_b
Analogue Composite:	625-line composite PAL, or 525-line NTSC-M according to input signal
Video monitor out (optional):	Digital ITU-R Rec. BT.656 4:2:2

Audio inputs

Two L/R pairs of balanced analogue, XLR female connectors, 600 Ω impedance.

Digital audio according to the EBU/AES Interface.

The compression algorithm to be used shall be stated by the manufacturer.

Audio outputs

Balanced analogue, two L/R pairs.

Digital audio according to the EBU/AES Interface.

Ancillary data I/O

In place of one of the analogue sound pairs, it shall be possible to carry a 2 Mbit/s data signal as follows:

– Serial 2.048 Mbit/s via 75 Ω unbalanced connection, in accordance with Rec. G.703.

Remote control and monitoring (coder and decoder)

Asynchronous serial port to RS-232D or an RS-485 port, 9-way D-type female connector.

Network Data Connection

It may be necessary in some cases to separate the codec and modem sections of the equipment and to operate over public networks using G.703 interfaces. For direct or private connection, RS-422 could be used.

G.703: 34.368 Mbit/s CCITT Rec. G.703, 75 Ω unbalanced BNC female connector

RS-422: RS-422,15-way, D-type female connector

Operational features

Video inputs

Selection of the analogue or the digital input signal shall be by means of a remote control switch.

The composite analogue input shall automatically decode PAL, or NTSC, in accordance with the input signal.

When accessed through the digital interface, the codec shall automatically support 625- and 525-line systems.

The video format including aspect ratio should be signalled in the video multiplex.

Video outputs

The decoder shall have a 270 Mbit/s serial digital output plus two composite analogue outputs.

continued ...

EUROVISION

EBU user requirements for digital television codecs *(continued)*

The serial digital output shall be available at all times.

If the encoder's composite analogue input is selected, the outputs shall automatically follow the encoder's composite analogue input signal standard, namely PAL or NTSC.

If the encoder's serial digital input is selected and is being fed with a 270 Mbit/s 625-line signal, the decoder's outputs shall give a 625-line output.

If the encoder's serial digital input is selected and is being fed with a 270 Mbit/s 525-line signal, the decoder's outputs shall give a 525-line output.

Monitor video output

Each coder and decoder (optional) shall have a 4:2:2 digital monitor video output conforming to CCIR Rec. 656.

Composite decoding/recoding

The EBU network will be component-based and composite sources may feed destinations operating in component mode.

Luminance/chrominance separation in the PAL decoders shall be very high quality, state-of-the-art.

Composite coders in the decoders shall be protected against wide-bandwidth chrominance signals from component sources.

Audio

Two stereo/2-channel audio inputs/outputs shall be integrated in the codec.

In accordance with EBU Rec. R64 and R68, the headroom will be 18 dB.

It shall be possible to set levels without extracting the cards from the frame

The sampling frequency used for audio analogue-to-digital conversion at the encoder should be locked to the video time-base and should neither be free-running nor locked directly to the transmission network clock.

Summing/splitting networks for stereo/mono operation will be provided externally by the EBU.

Video audio delay

The audio/video timing error shall not exceed ± 2 ms. Performance will be tested by means of a recorded sequence of video with cue dot and audio tone burst.

End-to-end transmission delay

The end-to-end transmission delay is important for some types of programme. It shall be minimized and stated in the offers. The total encoding and decoding time shall not exceed 300 ms.

Insertion data signals, IDS, and Insertion test signals, ITS.

The encoder/decoder combination shall transmit IDS/ITS transparently, if IDS is present on the analogue input signal. This shall include the noise which is present on line 22 of the input signal.

Note:

IDS shall be transmitted on lines 16, 329.

ITS shall be transmitted on lines 17, 18, 330, and 331.

If IDS is not present on the incoming signal, the encoder will insert its own IDS, and preferably also a new ITS, including a blanked line 22.

Encryption

For the initial requirement, a simple key should lock and unlock the signal at the sending and receiving ends. The system shall be upgradable to a full private key encryption operation which permits over-air addressing of receivers.

Teletext and Time Code information

There is no requirement to transmit Teletext or Time Code information on the Eurovision network.

Genlock

There is no requirement to genlock the decoder output to local reference signals such as black and burst.

System Monitoring

It shall be possible to monitor and control the encoder and decoder remotely by means of an asynchronous serial data RS-232 connection or a RS-485 connection.

The decoder monitoring shall take account of the encoder status as communicated by the supervision channel and the status of the data channel as determined by error statistics or by other means.

Video sync loss

In the event of loss of the video sync input to the encoder for more than 1 second or encoder failure, not entailing loss of the data output, the decoder shall provide black level at its video output.

Transmission loss

In the event of marred transmission between the encoder and decoder, the decoder shall be controllable to provide either:

– the video output, including any errored pixel blocks, or;

– initially a freeze of the last received video signal, changing to mid grey level after five seconds.

If the fault condition affects the audio only, information shall be provided at the monitoring output.

Short breaks

Momentary interruption of the video sync input shall require not more than 0.5 seconds of restoration time.

The restoration time after a momentary interruption of the network data signal, once the demodulator has re-synchronized, shall be minimized and stated in the offers.

Input hum

The performance shall not suffer permanent harm from the presence of 2 volts of mains hum on the incoming video audio or data or serial digital connections.

Input overload

The codec is required to operate in a mixed analogue/digital network. Level control on the analogue sections is not perfect. The codec is required to accept analogue input level variations without producing serious impairments to the signal.

Output residual DC

The level of any residual DC on the video output shall not exceed 0.1 volt in 75 Ω.